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RECENT MIGRATION INTO AND WITHIN THE UPPER MISSISSIPPI DELTA OF LOUISIANA

By

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RECENT MIGRATION INTO AND WITHIN THE UPPER MISSISSIPPI DELTA OF LOUISIANA*

By

HOMER L. HITT

PART I

INTRODUCTION

The Problem

A narrow strip of bottom land paralleling the Mississippi River in the states of Louisiana, Arkansas, Mississippi, and Missouri is included in the Mississippi delta area. Flat topography and fertile soil distinguish it geographically from the neighboring upland hill sections. Equally important in setting the delta apart are numerous cultural features,[1] many of which arise directly from the geographical base. For the most part, these distinctive features are a complex of social and economic characteristics bound up with the dominant agricultural unit of the area—the cotton plantation.[2] Among these differentiating characteristics, largely derived from the prevailing system of large-scale agriculture, are a high population mobility, a concentration of land ownership, a heavy proportion of croppers and day laborers, a low level of living, and a high percentage of Negroes.[3]

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* In cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture.

[1] The distinctive cultural character of the Mississippi delta area is clearly indicated by A. R. Mangus' statement: "Though a part of the *Old South,* this region is culturally unique among the thirty-two rural-farm regions of the United States." *Rural Regions of the United States,* Research Monograph, Works Progress Administration, Washington, D. C., 1940, p. 22.

[2] Although plantations are widely distributed throughout the Southeast, their greatest concentration is within the Mississippi delta area. See T. J. Woofter, Jr., et al., *Landlord and Tenant on the Cotton Plantation,* Research Monograph 5, Works Progress Administration, Washington, D. C., 1936, p. 5. Also cf. T. Lynn Smith, *The Population of Louisiana: Its Composition and Changes,* Louisiana Agricultural Experiment Station Bulletin No. 293, Baton Rouge, 1937, p. 8, and C. O. Brannen, *Relation of Land Tenure to Plantation Organization with Developments Since 1920,* Ph.D. Thesis, Fayetteville, Arkansas, 1928, p. 7.

[3] See T. Lynn Smith's discussion of the social effects of large-scale agriculture in *The Sociology of Rural Life* (New York: Harper & Brothers, 1940), pp. 301 ff.

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This study is concerned with the nature and extent of recent migration into and within that portion of the Mississippi delta included in the State of Louisiana[4]. (See Figure 1.) Explicit in this statement is the aim to explore the character of the movement from other regions, par-

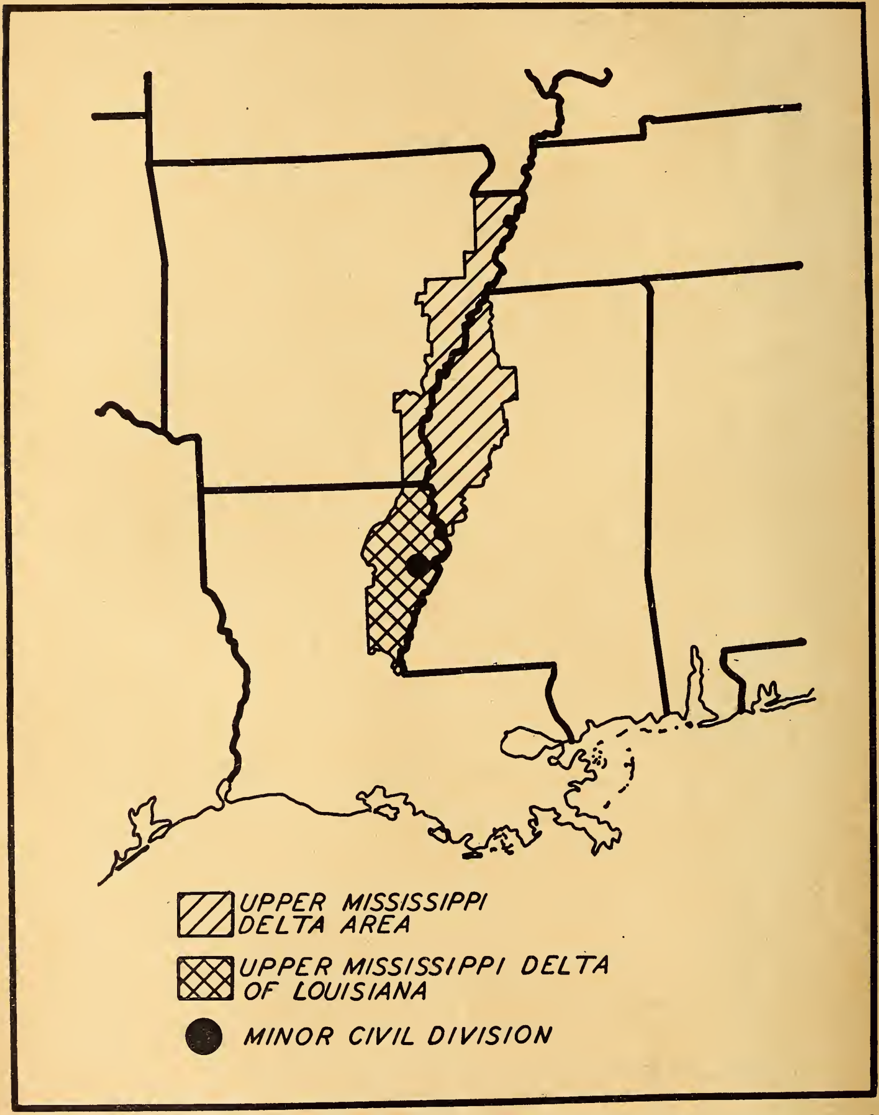
UPPER MISSISSIPPI DELTA AREA
UPPER MISSISSIPPI DELTA OF LOUISIANA
MINOR CIVIL DIVISION

FIGURE 1. The Mississippi Delta Area Showing the Upper Delta Area of Louisiana and the Location of the Survey Minor Civil Division.

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[4] For the purposes of this study, the first and second tiers of parishes west of the Mississippi River in north Louisiana were assumed to comprise the upper delta area of Louisiana. However, the marked geographical and cultural homogeneity prevailing throughout the entire delta renders many of the findings and interpretations applicable to the area as a whole.

ticularly the upland hill areas, to the delta as well as that occurring within the delta itself. Although both of these movements involve the spatial rearrangement of people, they differ widely in other respects. A transfer of residence from non-delta to delta area requires a basic social and economic readjustment on the part of the migrant family. Although the migrant's place of origin is within the cotton South, the unique features of the highly specialized plantation economy compel a radical revision of the accustomed way of life.[5] Such, however, is not the case for moves having their origins and destinations within the homogeneous plantation area.

Movements confined to the area, nevertheless, are of great importance. The resident farm population of no other major region is, perhaps, characterized by such a high rate of inter-farm movement. Although, on the whole, these moves are for short distances, a considerable share of them are socially significant in that they necessitate the breaking of old social bonds and the formation of new ones.[6] Indeed, one study concluded that the frequency of residential changes in the delta "affects adversely the entire social structure of the area."[7]

Migrations into and within the Mississippi delta area unquestionably have long been important population movements. Recently, however, there has been interposed into the dominant plantation economy a new factor that obviously has a major bearing on these movements into and within the delta area. This factor is the extensive opportunity for settlement offered by the opening and sale of cut-over new ground in family-size farm units. The significance of this settlement, occurring for the most part since 1935, is emphasized by the following excerpt from a government publication:

> A new "land rush," a movement of national significance, is underway in the poorly drained cut-over areas of the Mississippi Delta, in Louisiana, Mississippi, and Arkansas. New settlers are streaming in each year, and attempting to clear the land for agriculture. Since millions of acres of land are still waiting for settlement, it seems probable that continued migration and settlement can be expected.[8]

The inward surge of families to take over the new ground farms has become a definite and sizeable current in the general pattern of farm migration in the delta area. Moreover, as a result of the opportunities still available, it promises to become an even more important part of the general picture in the future.

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[5] For a detailed analytical description of the social and economic characteristics of the plantation economy, see T. J. Woofter, Jr., et al., *op. cit.*

[6] T. Lynn Smith stated that "The socially significant move is the one that involves the shattering of old group bonds and the establishment of new ones, or rising or sinking from one social class to another. Either distance or the crossing of political boundaries may be a very poor index of this social mobility." "Characteristics of Migrants," *The Southwestern Social Science Quarterly,* Vol. XXI (March, 1941), p. 336.

[7] Max R. White, Douglas Ensminger, and Cecil Gregory, *Rich Land—Poor People,* Research Report 1, Farm Security Administration, U. S. Department of Agriculture, Indianapolis, January, 1938, p. 4.

[8] Interbureau Coordinating Committee, *New Ground Settlement in the Mississippi Delta,* U. S. Department of Agriculture, Washington, D. C., January 15, 1941, p. 1.

The Purpose

The purpose of this study is two-fold. First, it is concerned with the process of migration into a representative delta area of Louisiana between 1929 and 1939. In regard to this process, the study seeks to determine the approximate migration balance for the decade, the relative numerical importance among the migrants of households from non-delta compared with other delta territory, the annual trend of the inward movement, the geographic origins of the migrants, the rate of population turn-over characterizing the area, and finally, the reasons migrants give for moving.

Second, the study attempts to obtain some understanding of the characteristics of the two types of migrant households, those from non-delta and those from delta areas. These characteristics are brought into sharp focus, and their significance revealed, through comparison with corresponding data for the immobile or sedentary households. The characteristics to be analyzed in this manner include those relating to age, family type, education, occupation, and levels of living. Moreover, throughout the analysis, the precise roles of race, type of operating unit, and new ground settlement in the migration pattern are observed.

The Sample

The first question concerns the selection of a unit of sampling, or the specific item for enumeration. Units available for use in rural areas range from an individual farm to an entire county. Actually, however, one or a combination of minor civil divisions represents the largest sampling unit suitable for most field surveys. Both the individual farm and the minor civil division possesses peculiar advantages.[9] Despite the unsurpassed statistical potentialities of the individual farm, it was decided that the minor civil division would better fulfill the needs of this study.[10]

Remaining was the important task of selecting a representative minor civil division for enumeration. The following criteria were used in making this selection: (1) The large-scale plantation system of agriculture, traditionally and currently characteristic of the delta area, should predominate in the sample minor civil division. (2) A considerable representation of the recently settled, new ground farms should be included in the minor civil division. (3) The population of the minor civil division should correspond closely to that of the Louisiana delta area with respect to such compositional items as age, sex, and race. (4) Finally, the total number of farm households residing in the minor civil division should be commensurate with the time and money allotted for the field survey.

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[9] For an elaboration of the relative advantages of these two sampling units, see Homer L. Hitt, "A Sampling Technique for Studying Population Changes in Rural Areas," *Social Forces,* Vol. XIX (December, 1940), pp. 208-213.

[10] The choice is based on two considerations: (1) the expense and time required in obtaining the same number of schedules are less for the minor civil division; and (2) the use of the minor civil division as the unit permits the relating of collected data to comparable information for the census years.

On the basis of these criteria the rural-farm portion of Ward 2, Tensas Parish, situated within a few miles of the Mississippi River in the heart of the upper delta, was selected as representative of the Louisiana delta area. As complete an enumeration as possible of the sample ward yielded migration records for 660 resident farm households. These records constitute the basic data for this study. Slightly over three-fifths (410) of the enumerated households were Negro, and the remainder (250) were white. Over two-thirds (451) of the 660 households were residing on plantations[11] when enumerated and slightly less than one-third (209) on family-size farms. Seven-tenths (148) of the 209 households on family-size farms reported that their land was considered new ground in the area.[12]

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[11] In this study large continuous tracts of land under one management and operated as a unit with respect to the handling of labor and products were classified as plantations. Only rarely did they have less than five resident families and frequently they had more than 15 to provide labor.

[12] For information regarding the similarities and differences between the recently settled new ground families and their neighbors residing on plantations and on the long-cultivated family-size farms of the upper Mississippi delta of Louisiana, consult Homer L. Hitt, "A Comparative Analysis of the People on New Ground Farms, Plantations, and Old Family Farms in the Upper Mississippi Delta of Louisiana," *Rural Sociology*, Vol. 7 (December, 1942) pp. 404-414.

PART II

THE MIGRATION PROCESS

Estimate of Migration in and out of Sample Area, 1930-1940

Although the basic data for this study afford a fairly complete source of material on the process of migration into the area, they do not provide information on migration out of the area. That some migration from the area did occur, however, is certain.[13] Since this outward flow of population has an important bearing on the movement of people into the area, it is desirable to know two things: (1) Did the counter-currents of migration in operation result in a net loss or net gain of population, and (2) approximately how much movement took place in both directions to bring about the net change? In spite of the fact that precise answers to these questions are denied by the lack of certain data, relatively valid approximations may be made from a combination of census items on population, vital statistics data, and information secured in the field survey.

Through the use of suitable statistical procedure it is possible to obtain helpful if only approximate answers to the two queries posed above. In regard to the first question the evidence indicates that, through movement in and out, the sample minor civil division gained about 330 more persons than it lost between 1930 and 1940. This relatively small net migration gain is of special interest in view of the 148 households including over 600 persons enumerated in 1939 on new ground farms which were non-existent in 1930. In answer to the second, it may be estimated that a minimum of over 950 persons departed from the ward coincidental with the arrival of 1,287 persons. This means that the ward line was crossed in either one direction or the other about seven times for every person that entered and remained until the enumeration in 1939.

These data make it appear that a net gain through migration accounted for over two-fifths of the total increase in the farm population of the sample minor civil division in the intercensal period, 1930-1940. The balance of the increase resulted from the excess of births over deaths. The large number of persons entering relative to the net gain experienced can be explained only in terms of huge streams of migrants moving both into and out of the sample ward. Since the net migration gain of the minor civil division amounted to only a little over one-half of the number enumerated in the 1940 census on recently settled new ground farms, it is probable that the population of the long-cultivated plantation section of the ward sustained a substantial loss. For the total delta area these findings may have the following implications: (1) The amount of new ground settlement occurring in the delta parishes since 1930 may have a distinct bearing on whether the total farm population of each showed an increase or a decrease through migration between 1930 and 1940. (2) Small net changes in total numbers in some parishes may obscure marked spatial redistributions of the farm population.[14]

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[13] E. G. Ravenstein is usually credited with the original statement of this phenomenon. It was expressed by him as follows: "Each main current of migration produces a compensating counter-current." "The Laws of Migration," *Journal of the Royal Statistical Society,* Vol. 48 (1885), p. 198.

The Fundamental Residential Categories

As indicated above, the objectives of this study, posed in their most general terms, are to ascertain the nature of migration both into and within the upper Mississippi delta of Louisiana. More specifically, this study seeks knowledge of the frequency and the nature of these two types of movement, as well as the social and economic characteristics of the movers participating in each type. This information is brought into sharper focus, and its fuller significance revealed, through comparison with corresponding data for the lack of movement and for immobile households. These considerations narrow the field of potential residential categories to the three: immobile households, households migrating within delta area, and households moving into delta area.

How shall each of these categories be defined? The criterion of migration used for this study is the entering of the minor civil division during the ten-year period, 1929-39. The inclusion of the entering households in one or the other of the two migrant groups depends on the territorial limitations of the delta area. Since the homogeneous strip-like Mississippi delta area lies partially in the states of Arkansas and Mississippi, as well as in Louisiana, households remaining within the entire delta, irrespective of states, are included in one group. However, the limits of the entire delta area are neither coincidental with legal boundaries, as county lines, nor are they so clearly apparent that their location is universally agreed upon. For this purpose the counties ordinarily considered more largely situated within than without the delta area were included in the delta, as is shown in Figure 1.

On the basis of these considerations, the households enumerated in the sample minor civil division were classified into the following categories: (1) households remaining within the sample minor civil division (Ward 2, Tensas Parish), 1929-39; (2) households remaining within the *entire* delta area but *not* within the sample minor civil division, 1929-39; (3) households moving from non-delta territory to the delta area, 1929-39. Approximately four-ninths (292) of the 660 households remained throughout the ten-year period within the sample ward, three-tenths (211) entered the ward but had, nevertheless, remained in the delta area, and about one-fourth (157), the remainder, entered both the delta area and the ward. It is important to note that the two migrant classes include only those entering households which remained until the enumeration in 1939, and are therefore residual migrant groups.

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[14] Consult Homer L. Hitt and T. Lynn Smith's "Population Redistribution in Louisiana," *Social Forces,* Vol. XX (May, 1942), pp. 437-444.

Race. Negro households move less frequently than the white households and the moves they make are for shorter distances. This finding is in substantial agreement with other studies that have dealt with general bi-racial migration differentials in the South.[15] The racial difference is disclosed by the relative number of the white and Negro households in each of the fundamental residential categories. (See Table I.) The Negro households, as compared with the white, were concentrated to a much greater extent in the immobile group which remained for the ten-year period within the sample ward. The whites, on the other hand, were more frequently included in the two migrant groups, particularly the one comprised of households from non-delta territory.

TABLE I. HOUSEHOLDS IN EACH OF THE THREE RESIDENTIAL CATEGORIES, CLASSIFIED BY RACE AND BY TYPE OF OPERATING UNIT

RACE AND TYPE OF OPERATING UNIT	TOTAL		WITHIN WARD		WITHIN DELTA		INTO DELTA	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Race								
TOTAL	660	100.0	292	100.0	211	100.0	157	100.0
White	250	37.9	47	16.1	91	43.1	112	71.3
Negro	410	62.1	245	83.9	120	56.9	45	28.9
Type of operating unit and race								
TOTAL	660	100.0	292	100.0	211	100.0	157	100.0
Family-size farm	209	31.7	80	27.4	63	29.9	66	42.0
Plantation	451	68.3	212	72.6	148	70.1	91	58.0
White	250	100.0	47	100.0	91	100.0	112	100.0
Family-size farm	137	54.8	24	51.0	51	56.0	62	55.4
Plantation	113	45.2	23	49.0	40	44.0	50	44.6
Negro	410	100.0	245	100.0	120	100.0	45	100.0
Family-size farm	72	17.6	56	22.9	12	10.0	4	9.0
Plantation	338	82.4	189	77.1	108	90.0	41	91.0

Type of Operating Unit: Plantation and Family-size Farm. The Negro tends to be a plantation dweller. In comparison, the white more frequently resides on a small independent farm. This affinity between the Negro and the plantation has been observed throughout the delta area.

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[15] T. J. Woofter, Jr., et al., *op. cit.*, p. 110; T. Lynn Smith, *The Sociology of Rural Life*, p. 191. Harold Hoffsommer, *New Ground Farmers in the Mississippi River Delta*, Bureau of Agricultural Economics and Louisiana Agricultural Experiment Station, cooperating, Washington, D.C., April 5, 1941, p. 10.

T. Lynn Smith has aptly posed the situation as follows: "Neither the Civil War, Reconstruction, the boll weevil, nor the great depression has been sufficient to destroy the tenacious three-way association between good land, the plantation, and the Negro."[16] Of the 660 households included in this study, over two-thirds were residing on plantations when enumerated and slightly less than one-third on family-size farms. The Negro households comprised five-eighths of the total sample, over two-thirds of the plantation group, but only one-third of the family-size farm group. White households, however, made up three-eighths of the total sample, less than one-third of the plantation group, but two-thirds of the family-size farm group.

The migration pattern of the households residing on family-size farms resembled that of the whites whereas the migration pattern of the plantation households was similar to that of the Negroes. (See Table I.) These similarities are to be expected from the above-mentioned unequal distribution of the racial groups on the two types of operating units. The question arises, however, whether or not the difference in migration between the families on plantations and those on individual farms is a function of the racial difference in migration. That the racial difference is largely responsible for the respective migration patterns of the plantation and family-size farm households is disclosed by comparing the migration patterns of the two groups of households for each of the two races separately. Among the whites the migration difference between the households on family-size farms and those on plantations is small and of little significance. However, among the Negro households, those residing on the plantations were migrants both from within and without the delta in greater numbers than would be expected from their representation in the total sample. Nevertheless, in the main, the divergent patterns of mobility characterizing the households on plantations and those on family farms appear to be determined by the relative concentration of Negroes among the former and whites among the latter.

Type of Land: New Ground and Old Ground Family-size Farms. The most significant socio-economic development occurring in the upper Mississippi delta during the past decade has been the rapid settlement of farm households on small, supposedly family-size parcels of cut-over land, or of "new ground" as it is popularly termed in the area. However, long before the recent increase of family-size units in the delta as a result of the new-ground settlement, a scattering of family-size farms was interspersed among plantations throughout the area. Both of these types of family-size farms are present in the sample minor civil division, though in number the new ground farms have already far outstripped the ones situated on the old land. As has been stated, seven-tenths (148) of the 209 households residing on family-size farms reported that their land was thought of as "new ground" in the area.

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[16] *Op. cit.*, pp. 304-305. Also see T. Lynn Smith, *The Population of Louisiana: Its Composition and Changes*, p. 8.

Both significant and interesting is the relative concentration of the white households on the "new ground" farms and of Negro households on the "old ground" farms. (See Table II.) Approximately two Negro households for one white household were present on the old ground individual farms, whereas there was only one Negro for every four white households on the new ground farms. Other investigations indicate that this one to four ratio of Negroes to whites prevails throughout the new ground area of the upper delta of Louisiana.[17] This relative deficiency of Negro households on the new ground farms has been attributed to various aspects of racial discrimination such as (1) the economic disadvantage of the Negro; (2) the preference of some land vendors for white purchasers; and (3) the greater demand for the Negro on the plantation. The new ground settlement has already materially affected the racial balance in the delta,[18] and if in the future this settlement continues as predicted and the same ratio of whites to Negroes among the settlers maintains, the proportion of the total delta population constituted by whites will experience a significant increase.

TABLE II. TOTAL HOUSEHOLDS AND FAMILY-SIZE FARM HOUSEHOLDS ON NEW AND OLD GROUND, CLASSIFIED BY RACE

			FAMILY-SIZE FARM HOUSEHOLDS					
	TOTAL SAMPLE		TOTAL		NEW GROUND		OLD GROUND	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
TOTAL	660	100.0	209	100.0	148	100.0	61	100.0
White	250	37.9	137	65.5	116	78.4	21	34.0
Negro	410	62.1	72	34.5	32	21.6	40	66.0

Institutional repercussions doubtlessly have already been felt as a result of the racial shift now in progress. Educational, religious, and political readjustments are inevitable. The direction which may be taken by the political changes is of special interest. The increase of potential voters outside the traditional plantation structure has extreme political importance for the delta area. Heretofore, suffrage among the farmers of that area, for the most part, has been restricted to the planter class and to a relatively small number of white croppers and laborers dependent upon the planter class. Consequently, a rapid increase of the white new ground farmers may exercise a significant influence on local government.

The high proportion of the new ground households that are white is reflected in their residential distribution. (See Table III.) The households on the new ground farms made up a relatively small proportion of the group remaining within the ward but large proportions of the groups moving about within the delta and into the delta. It appears then that the new ground farms tended to attract households that entered the minor civil division after January 1, 1929. On the other hand, the households residing on old ground, predominantly Negro, were relatively concentrated in the group remaining within the ward and infrequently included in either of the two migrant groups.

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[17] Hoffsommer, *op. cit.*, p. 21. See also Philip E. Jones, John E. Mason, and Joseph T. Elvove, "New Settlement in the Delta and the Lower Mississippi Valley," *The Journal of Land and Public Utility Economics*, Vol. XVII (November, 1941), p. 467.

[18] In the past decade the proportion of the rural-farm population of the eight northeastern Louisiana parishes classified as white increased from 46.1 per cent to 49.6 per cent.

TABLE III. FAMILY-SIZE FARM HOUSEHOLD IN EACH OF THE RESIDENTIAL CATEGORIES, CLASSIFIED BY RESIDENCE ON NEW AND OLD GROUND

	TOTAL		WITHIN WARD		WITHIN DELTA		INTO DELTA	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
TOTAL	209	100.0	80	100.0	63	100.0	66	100.0
New Ground	148	70.8	44	55.0	51	81.0	53	80.0
Old Ground	61	29.2	36	45.0	12	19.0	13	20.0

Annual Volume of Movement into Area, 1929-1939

The preceding analysis revealed that of the 1939 resident farm households over one-half moved into the minor civil division and one-fourth moved into both the delta area and the minor civil division during the previous decade. Especially important to a better understanding of the migration process is the annual trend of these movements as well as of that to present farms. Was the volume distributed more or less evenly over the decade, or did the bulk of the transfers occur in particular years?

Year of Movement to Present Farm. The recency of the greater part of the transfers to present farms reflects the utilization of new agricultural opportunities as well as the rapid turnover of population. Only one-sixth (110) of the 660 households had remained on the same farm throughout the ten-year period studied. The balance, five-sixths, moved to their present farm between January 1929 and July 1939. Most of the households came to their present farms after 1935. (See Figure 2). This movement was heaviest in 1938 when 128 or almost one-fourth of all households transferred to their 1939 place of residence. However, almost as many moved in the first six months of 1939. During the 18 months prior to the survey (1938 and half of 1939), then, slightly less than one-half of all households moved to the farms on which they were enumerated. As would be expected from their relatively greater residential stability, Negro households arrived on their farms somewhat earlier in the decade than the white households. In general, the farm households residing on the new ground had been there only a short time, almost four-fifths of them occupying their present farms in the four years 1936, 1937, 1938, and 1939.

Year of Movement to Sample Minor Civil Division. Considerably over half of the 660 households enumerated in 1939 moved into the minor civil division after January 1, 1929. These moves into the ward were relatively more numerous than moves to present farms in 1929 and in the early 1930's. Nevertheless, the majority (almost three-fifths) of these transfers into the ward were made after 1935. (See Figure 2.) The evidence of somewhat earlier movement to the ward, coupled with the fact that only two-thirds as many households moved into the ward as changed farms in the study interval, suggests the importance of short-distance moves as well as the gradual progression of households toward a given place of residence. Compared with the Negroes, the more mobile whites less frequently entered the ward in the first few years of the ten-year

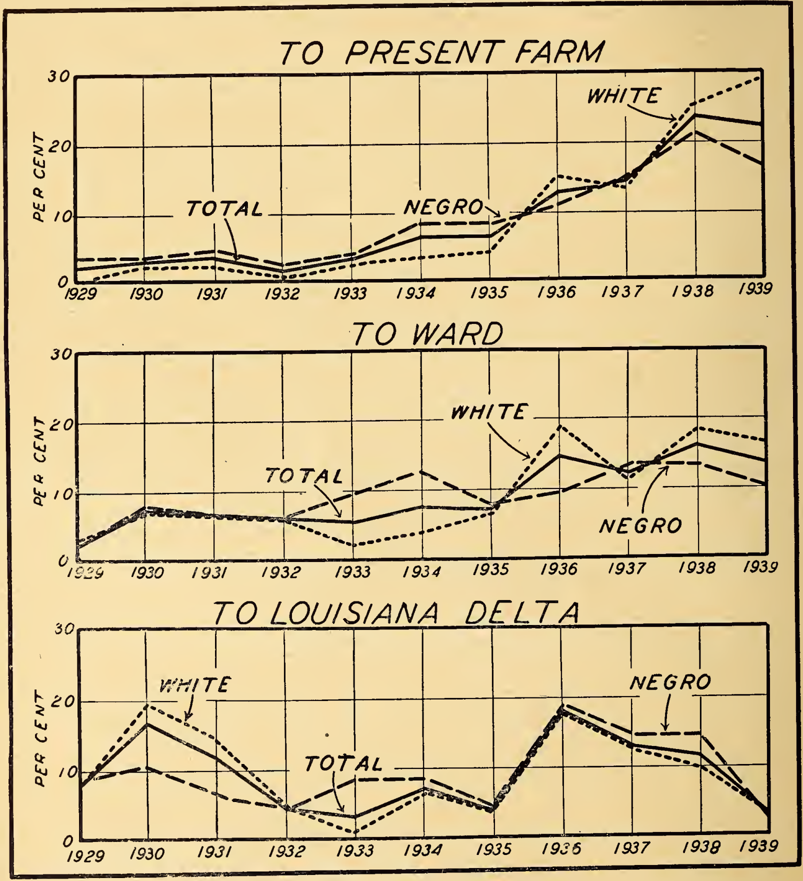

FIGURE 2. Year of Movement of Sample Households Moving to Present Farm, to Ward, and to Louisiana Delta, 1929-1939, by Race.

period but were relatively more numerous among the households passing over the minor civil division lines in 1936, 1938, and 1939. Two-thirds (104) of all households living on new ground farms in 1939 had entered the ward in the preceding ten years. Moreover, two-thirds of these entering new ground households as compared with slightly over one-half of the entering plantation households moved into the ward in the last four years of the decade studied.

Year of Movement to Upper Delta of Louisiana. The greater the distance and the more severe the necessary adjustments, the fewer are the migrant households. Over three times as many households changed farms and over twice as many entered the ward as moved into the delta area of Louisiana after 1928. Only one-fourth (160) of the households enumerated in Ward 2 moved into the delta area during the preceding decade. Further, these fewer households transferred somewhat earlier in the ten-year period, one-third of them entering the Louisiana delta in 1929, 1930, and 1931. (See Figure 2.) For the most part, then, the households living on given farms in the Louisiana delta did not move great distances directly to those farms but rather approached them gradually by several short moves. Another indication of the relative residential stability of the Negro is the fact that only three-tenths (48) of the households entering the upper Louisiana delta but three-fifths of the total sample were of this race. Slightly over one-third (52) of the households enumerated on new ground reported having moved into the Louisiana delta in the preceding ten years. More than half of these entering new ground households arrived in the delta prior to 1935.

Geographic Origins

Geographically speaking, migration is a "give and take" proposition. Every migrant entering an area has been given up or sent by another area. Information relating to the origin of migrants enables one to discover what localities are giving up the human resources gained by the area of destination. Until this is known, any consideration of motivations for migration necessarily ignores the socio-economic conditions at the point of origin and, therefore, at best can be only partially valid.

In a general way geographic origin is indicative of cultural origin. People, least of all farmers, leave behind little of their cultural background when they take up residence in a different geographical area.[19] The religious beliefs, the political ideals, the educational achievements, the occupational skills, all these and many other traits, basic to the process of social adjustment and assimilation in the area of destination, are frequently determined largely by the circumstances prevailing in the area of origin. It is no wonder, then, that the social situation growing out of a population influx in any given locality of destination can be understood only in terms of the migrants' origins.

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[19] The determinative importance of the "mental luggage" of the migrants who settled Colorado is stressed by R. W. Roskelley. See his monograph, *Population Trends in Colorado,* Bulletin 642, Colorado Agricultural Experiment Station and Federal Work Projects Administration, Fort Collins, 1940, p. 5.

Birthplace of Heads of Households. One precise approach of universal application in delimiting geographic origin is birthplace. Although birthplace *per se* gives no exact information on the important question of length of residence, it does ordinarily indicate some residence at the place by the parents as well as the offspring, a circumstance that would perhaps strengthen the imposition of the cultural stamp of that geographical area on the individual. In view of this, the birthplaces of the heads of the 660 farm households are analyzed to determine the role of various states, of upland versus delta areas, of distant versus nearby localities, in furnishing migrants to the sample minor civil division.

(1) *State of Birth.* The majority of the heads of households (three-fifths of the 660) reported Louisiana birthplaces. (See Table IV.) An additional fifth (144) reported Mississippi as their state of birth. Only one-sixteenth (45) were born in Arkansas, the state of next importance. Alabama and Texas were the birth states of 11 and eight heads of households, respectively. The balance (50) were born in other states, which, for the most part, are located in the Southeast.

TABLE IV. WHITE AND NEGRO HEADS OF HOUSEHOLDS CLASSIFIED BY STATE AND AREA OF BIRTH

STATE AND AREA OF BIRTH	TOTAL		WHITE		NEGRO	
	Number	Per cent	Number	Per cent	Number	Per cent
State of birth						
TOTAL	660	100.0	250	100.0	410	100.0
Louisiana	402	60.9	87	34.8	315	76.8
Mississippi	144	21.9	77	30.8	67	16.4
Arkansas	45	6.8	38	15.2	7	1.7
Alabama	11	1.7	8	3.2	3	.7
Texas	8	1.2	6	2.4	2	.5
Other	50	7.5	34	13.6	16	3.9
Area of birth						
TOTAL	568	100.0	194	100.0	374	100.0
Upland area	234	41.2	149	76.8	85	22.7
Delta area*	334	58.8	45	23.2	289	77.3

*Includes Red River delta and Mississippi delta of Louisiana, Yazoo-Mississippi delta of Mississippi, and Arkansas River valley and Mississippi delta of Arkansas.

Sharp differences exist between the heads of white and Negro households with respect to state of birth. Louisiana-born Negroes are much more numerous than whites born in Louisiana. (See Table IV.) Slightly over three-fourths of the heads of the Negro households were born in Louisiana as compared with only one-third of the heads of white households. In contrast, proportionately, nine times as many whites were born in Arkansas, two times as many in Mississippi, over four times as many in Texas, and over three times as many in other states, as was the case for the Negroes. This relative concentration of Louisiana-born Negroes among the sample cases is indicative of the greater residential stability of the rural Negro.

For both whites and Negroes, heads of families on new ground were born in Louisiana less frequently than those residing on the old ground. More of the former, however, were born in Mississippi; among whites, they reported Mississippi as state of birth even more often than Louisiana.

(2) *Area of Birth: Delta Area versus Upland Area.* Already it has been emphasized that the Mississippi delta area, because of its flat topography, fertile soils, large plantations, and Negro population, presents a social and economic situation quite distinct from that of the neighboring upland hill territory. Consequently, a move from the more sterile upland farming section to the more fertile delta farming area necessitates a major readjustment on the part of the migrant as compared with a residential shift within the entire delta area. Furthermore, it has been suggested that hill areas, with high human fertility and low economic opportunity tend constantly to serve as areas of origin for migrants to less over-populated and economically more opportune flatlands. In order to ascertain the magnitude of the movement from the surrounding upland region, the birthplaces of the heads of households were classified into the two groups, upland area and delta area.[20]

The heads of Negro households, as a group, are native to the delta area, whereas the heads of the white households are foreign to the delta area. Two-fifths of the heads of all households were born in the upland area and three-fifths in the delta area. (See Table IV.) However, over three-fourths of the whites as contrasted with less than one-fourth of the Negroes were born in the upland area. The exact reverse was the case for the heads of households born in the delta; they constituted one-fourth of the whites but three-fourths of the Negroes. This racial difference in area of birth is pronounced for the persons on both the family-size farms and the plantations. It perhaps is partially related to distance and partially to the scarcity of Negroes in the upland areas from which migrants to the upper delta of Louisiana may be recruited. Reflecting the numerical dominance of the whites, two-thirds of the heads of households residing on new ground farms were born in the upland area.

(3) *Distance Between Birthplace and Residence.* In order to determine more conclusively the role of the distance factor, the 660 heads of house-

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[20] The birthplaces of 92 of the 660 heads of households were either too far removed from the immediate situation or were in neither type of area and therefore were eliminated from consideration.

holds were classified into the following categories: (1) birthplace within 50 miles from center of survey area; (2) birthplace 50-150 miles from center of survey area; (3) birthplace 150 miles or more from center of survey area.

The relative concentration of the Negroes' birthplaces in the proximity of the survey area make it appear that the whites migrate greater distances. (See Figure 3.) Seven-tenths (470) of all heads of households were born within a 50-mile radius of the center of the survey area, one-sixth (90) over 150 miles away, and the balance (100) between 50 and 150 miles away from the survey-area center. In this respect the whites and Negroes differed markedly. Less than one-half (113) of the 250 whites reported birthplaces within the 50-mile radius as compared with seven-eighths (357) of the 410 Negroes. Proportionately, almost four times as many of the former were born in the 50-150 mile range and over five times as many in the 150-mile-and-over range. Heads of white

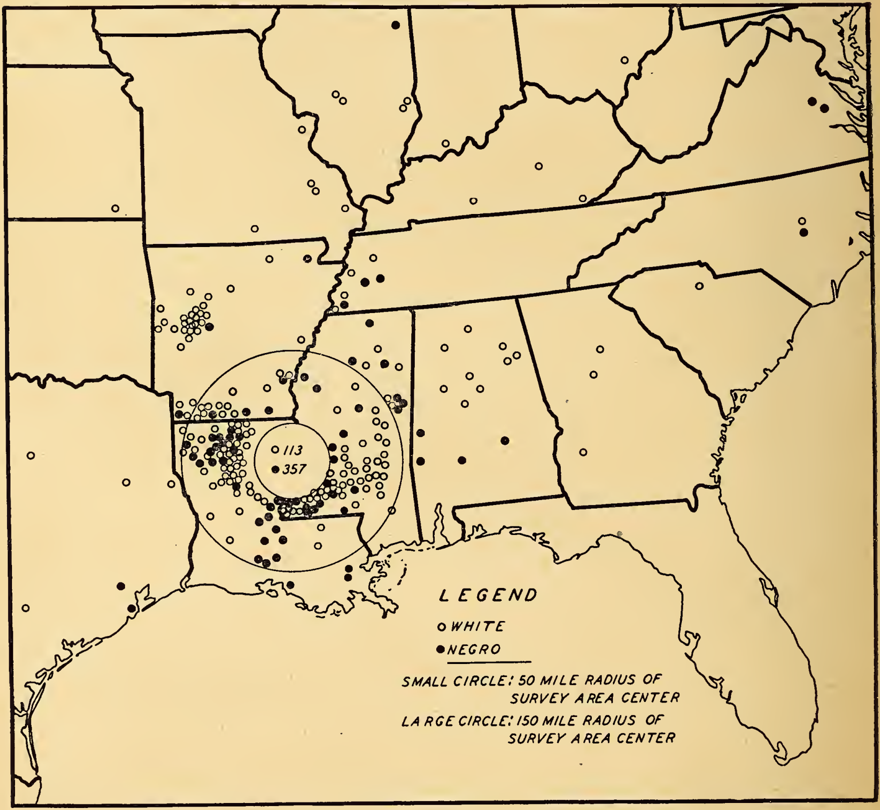
○ 113
● 357
LEGEND
○ WHITE
● NEGRO
SMALL CIRCLE: 50 MILE RADIUS OF SURVEY AREA CENTER
LARGE CIRCLE: 150 MILE RADIUS OF SURVEY AREA CENTER

FIGURE 3. Places of Birth of the White and Negro Heads of Households.

households since birth, then, moved farther than those of Negro households to get to the sample minor civil division.

Place of Residence, January, 1929. It is, of course, unlikely that many of the heads of farm households moved directly from their birthplace to the survey area. Rather, it is to be expected that the majority resided at one or more other places before arriving in the sample minor civil division, or especially, prior to occupying the farms on which they were enumerated. These places of residence interspersed between place of birth and present farm are also significant from the standpoint of geographic origin. The attempt is made to get at this point by analyzing place of residence of the heads of households at the beginning of the period studied.

In January, 1929, one-sixth (110) of the 660 heads of households had already moved to the farms on which they were enumerated in the survey. (See Figure 4.) An additional 182 had entered the ward, making in all about four-ninths (292) of the sample cases. A total of 208 more

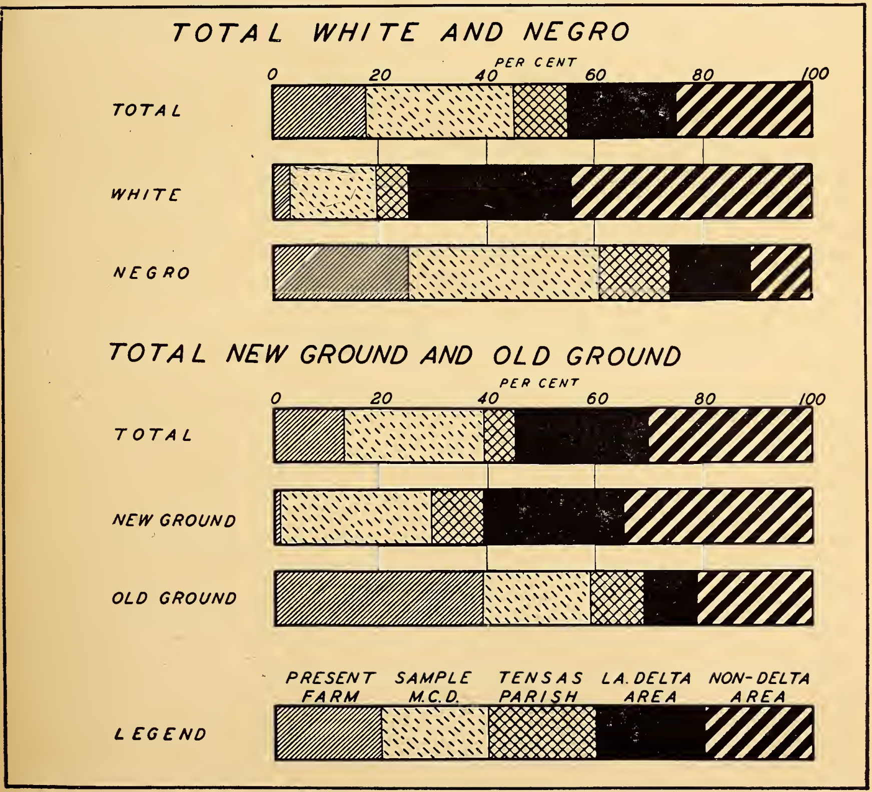

FIGURE 4. Place of residence in January 1929 of the Total, White, and Negro Households and the Total, New Ground, and Old Ground Households.

(three-tenths of the sample) were outside of the ward but in the upper Mississippi delta area of Louisiana. The remaining 160 heads of households,[21] one-fourth of the sample, were at this time still outside of the upper delta area of Louisiana.

The Negroes, as a group, had relatively short distances to move after 1929 to reach their 1939 places of residence. Contrasted with the whites, the heads of Negro households in 1929 were more frequently on present farms and in the sample ward and the parish, but were less often in the Louisiana delta area outside the parish and completely outside the Louisiana delta area. (See Figure 4.) Indeed, the whites, proportionately, were only one-eighth as frequently living on their present farms and only one-half as frequently living elsewhere in the sample minor civil division as were the Negroes. However, they were found over four times as often outside the parish in the Louisiana delta area and almost five times as often entirely outside the Louisiana delta area. The heads of white households, then, who were born farther than the Negroes from the center of the survey area, by January 1929 had progressed toward the survey area, but still remained, on the whole at more distant points than the Negroes.

Heads of the new ground households, compared with the heads of households residing on the longer cultivated "old ground," were conspicuously absent on their present farms in January 1929. (See Figure 4.) Also, they were living farther from the survey area, both within and without the Louisiana delta area. However, in the main, the movement toward the new ground farms was gradual rather than direct. Although only one-third of the heads of households were born in the delta area, two-thirds were resident there by 1929. Moreover, there is every indication that a plurality of moves was required to span the distance between the 1929 place of residence and the 1939 new ground farm. Consequently, the new ground settlers, for the most part, progressed by stages toward the new ground farms, most of them living in the immediate proximity some time before establishing residence on the new land. The plantation ordinarily was used as a way-station for both the white and Negro new-ground farmers. This means that movement directly from the upland hill section to the new-ground farming area assumed no significance by 1939.[22]

Non-Delta Residences from Which Heads of Households Entered Delta Area, 1929-39. The most significant geographic origin of the heads of households transferring from non-delta to delta territory between 1929-39 is the area of residence just before making the move. The population loss was an immediate shock to the social organizations of these areas, even if in the long run economic betterment may result. Also the way of life and thought of the entering migrants, crucial from the standpoint of social and economic adjustment in the new area, was partially predetermined by the conditions prevailing in these areas.

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[21] Only three of these 160 heads of households were in delta territory of other states.

[22] Cf. Homer L. Hitt, "Migration Among Delta Farmers," *Louisiana Rural Economist,* October, 1941.

Almost one-fourth (157) of the heads of 660 households enumerated in 1939 moved from non-delta area into delta area in the preceding ten years. Although whites constituted less than two-fifths of the total sample, seven-tenths (112) of those making the transfer were white. Obviously, the Negroes rarely participated in the movement from non-delta territory. Specifically, only 45, or about one-tenth of the heads of the Negro households, reported this type of residential change.

As expected, non-delta portions of Louisiana furnish a large share of the migrants, but Arkansas and Mississippi are well represented among them. Over two-fifths moved from parts of Louisiana, whereas approximately one-fifth of the total came from each Arkansas and Mississippi. Texas, although contributing only seven households, was next in importance and was followed by Alabama and Oklahoma, from which four and two households, respectively, moved. The balance (seven) came from scattered states.

Although the number of cases are few, a significant racial difference with respect to state of previous residence seems unquestionably indicated. (See Figure 5.) Proportionately, heads of white households came from Arkansas over three times as frequently as heads of Negro households. On the other hand, Mississippi was reported as the state of previous residence only one-third as often as for the Negroes. One reason for the large number of Negroes moving from Mississippi is their great frequency in the total population of that state. The heads of white households had come from "other states," more distant from the survey area than those cited above, about five times more often than the Negroes. This is in accord with the previous findings that whites more frequently were born some distance from the center of the survey area.

The specific areas of these states from which the migrants move to enter the delta area are significant. (See Figure 5.) The great majority came from the upland hill areas of Louisiana, Arkansas, and Mississippi, although a few were from other areas. The large number of whites who moved into the delta area from west-central Arkansas, particularly Yell County, is a most interesting phenomenon. The fact that within ten years a large number of the cases moved more than 200 miles from a relatively small area to a distinctively different socio-economic area and settled within the extremely small geographic unit, the sample ward, seems indicative of highly important non-economic factors influencing, if not determining, the origin and destination of migratory movements. It would appear that significant roles must be attributed to kinship and community bonds in this high correlation between geographic origin and destination. Perhaps migration does not as completely and finally sever an individual's or household's social ties with the "home folks" as has been stressed by some writers.

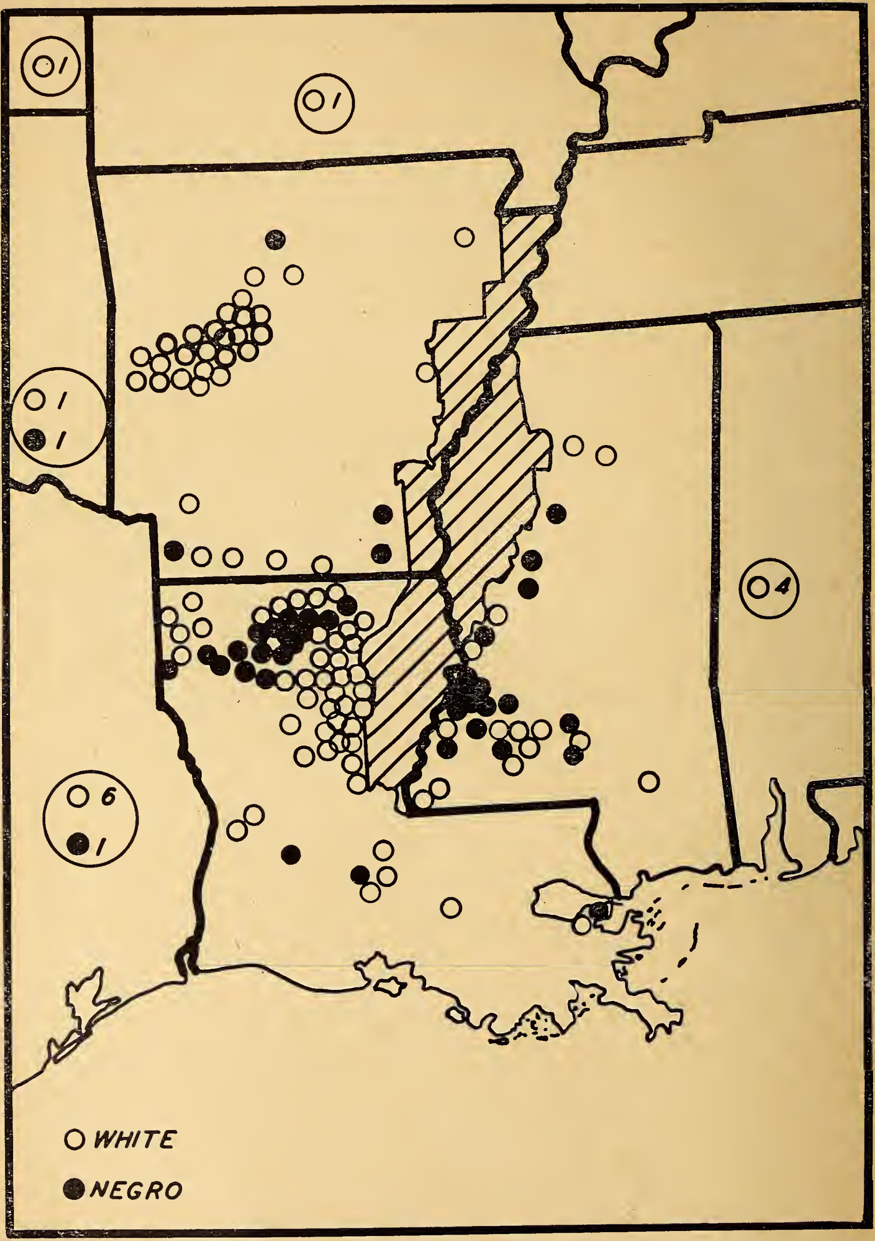

FIGURE 5. Non-Delta Residences from Which White and Negro Heads of Households Entered Delta Area, 1929-1939.

Turnover of Delta Population

The rate of turnover of a population is of great social importance. It is an index to the frequency with which most community bonds are broken and begun anew. That these breaches may occur too frequently for the effectiveness and solidarity of existing social organizations is evident, even though new persons or families are available to assume the social roles of the departed.[23] Moreover, the ill effects of a high population turnover are not visited solely on the group activities of an area. Farm resources and practices, likewise, fall below accepted standards when tenure of residence is insecure and short.[24]

Since, in this study, only entering migrants who remained and residents were enumerated, no check was secured on migrants leaving the area. Despite this lack, it was possible to obtain the following highly indicative measures of turnover: (1) median years of residence of the heads of households on present farms and in sample minor civil division, and (2) time of arrival of the heads of households on present farms, in ward, in parish, and in Louisiana delta. Finally, an attempt is made to ascertain the persistence of the farmers settled on the cut-over new ground.

Median Number of Years on Farm and in Minor Civil Division. Length of occupancy is related to population turnover. The longer the length of occupancy of present farms, the smaller the population turnover of the area is likely to be. However, this "length of occupancy" index assumes a relatively stable agricultural economy in which farming opportunities are primarily created by outward migration. Otherwise the entering of farm families for settlement on new land would tend to shorten the median length of occupancy although little or no turnover accompanied the movement. Because of the recent widespread settlement of cut-over new ground in the delta, the short length of occupancy of the settlers may distort the total picture. Since these settlers are, for the most part, white households on family-size farms, a racial and farm breakdown tends to segregate the recent migrants into the area who probably did not replace migrants from the area.[25]

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[23] That a high population turnover "affects adversely the entire social structure" is concluded by Max R. White, Douglas Ensminger, and Cecil L. Gregory, *op. cit.*, p. 4. Also see B. O. Williams, *Occupational Mobility Among Farmers,* Part I, "Mobility Patterns," South Carolina Agricultural Experiment Station Bulletin No. 296, Clemson, 1934, pp. 16 ff.

[24] C. E. Lively and Conrad Taeuber emphasized that a high population mobility "may aggravate the serious problem of soil conservation." *Rural Migration in the United States,* Research Monograph 19, Works Progress Administration, Washington, D. C., 1939, p. 123.

[25] The supposition that the sample households occupying the long-settled plantation area of the sample minor civil division more likely would have followed or replaced departing households, whereas, the families moving into the new ground area, in comparison, would have been preceded by other households less frequently. Since the white family-size farm households comprised the majority of the new ground settlers, a race and type of operating unit breakdown would tend to select out those entering households more likely not to have replaced departing families.

A high rate of population turnover prevails in the delta area. The median length of residence of the heads of households on present farms was 2.5 years. (See Table V.) Negroes, residentially more stable than the whites, are characterized by a slower turnover. The median length of occupancy of the heads of Negro households (3.4 years) was over twice that of the heads of white households (1.4 years). This racial differential is evident also in both the family-size farm and plantation groups. Even the few Negroes on the new ground definitely had been on their present farms longer than the corresponding whites, the median lengths of occupancy being 3.1 and 1.7 years, respectively.

TABLE V. THE MEDIAN NUMBER OF YEARS HEADS OF HOUSEHOLDS HAVE LIVED ON PRESENT FARMS AND IN THE SAMPLE MINOR CIVIL DIVISION, CLASSIFIED BY RACE AND TYPE OF OPERATING UNIT

RACE	TYPE OF OPERATING UNIT		
	Total	Family-size farm	Plantation
Present farm			
Total	2.5	2.5	2.5
White	1.4	1.5	1.2
Negro	3.4	5.5	3.3
Sample minor civil division			
Total	8.5	6.7	9.1
White	3.2	3.1	3.8
Negro	22.1	30.1	16.6

An analysis of the median length of residence in the sample minor civil division yields a similar but even more striking racial difference. The heads of the Negro households had lived in the minor civil division, proportionately, about seven times longer than the heads of white households. (See Table V.) This difference between whites and Negroes with respect to length of residence in the minor civil division was even more pronounced in the family-size farm group, slightly less so in the plantation group. The preponderance of whites among the heads of the family-size farm households and of Negroes among the heads of the plantation households appears to have caused the relatively shorter length of residence of the heads of all households on family-size farms. However, the Negroes on family-size farms reported a much longer median residence in the minor civil division than those on plantations.

The heads of the households on family-size farms had, on the whole, entered the sample minor civil division later than those on plantations. A greater turnover, however, cannot be imputed to the former, some of whom probably came in to take advantage of the new agricultural opportunities in the cut-over area, and consequently replaced no other households. The median length of residence in the ward of the heads of new ground households was 3.9 years.

Time of Arrival on Farm, in Ward, in Parish, and in Delta Area. The heads of households were classified into three arrival groups, before 1929, 1929-34, and 1934-39, with reference to time of each, occupying present farms, entering sample minor civil division, parish, and upper Mississippi delta of Louisiana. Then, the proportion in each arrival group was computed and charted for each of the points of destination. (See Figure 6.)

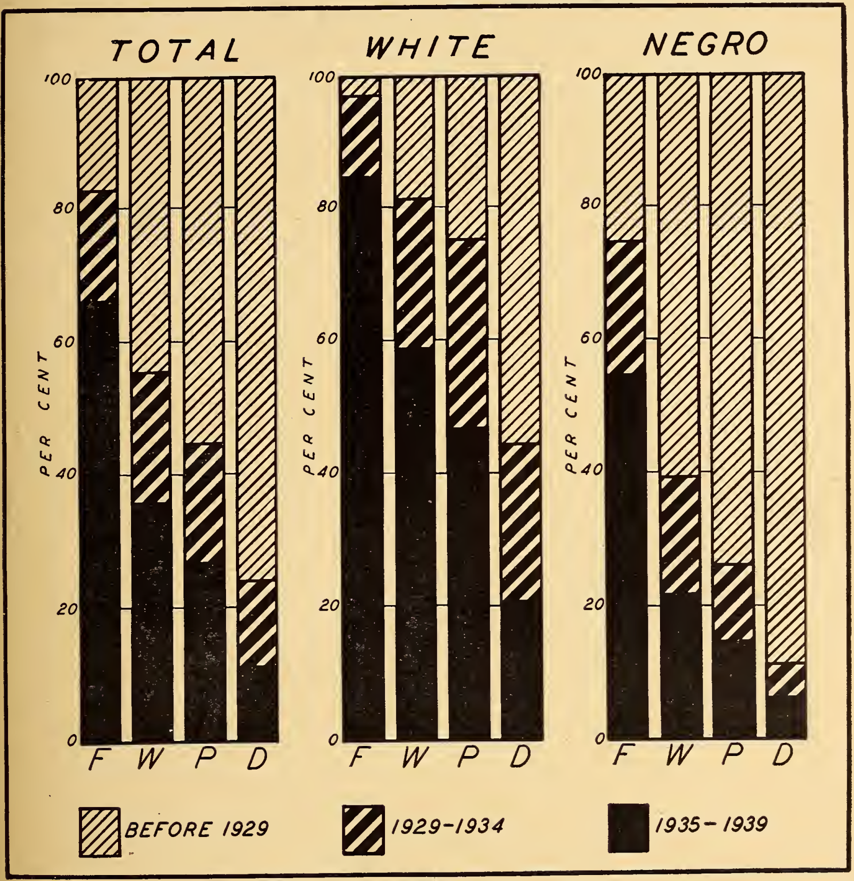

FIGURE 6. Time of Arrival of Total, White, and Negro Heads of Households on Farm, in Ward, in Parish, and in Delta Area.

Perhaps the most striking feature of the component-part bar chart is the convincing manner in which it illustrates the frequent occurrence of short distance moves in the delta area. Very infrequently did only one move result in the complete transfer from non-delta area to present farm. Of the 550 heads of households occupying present farms during the period studied, in January, 1929, one-third resided in the ward, one-eighth lived outside the ward but in the parish, one-fourth were outside the parish but in the Louisiana delta area, and less than three-tenths resided outside the Louisiana delta area. Consequently, few of the heads of households moving to present farms came from distant points.

The prevalence of a greater turnover among the whites is again indicated. A larger proportion of the heads of Negro households were present before 1929 in every case, on present farms, in the ward, in the parish, and in the Louisiana delta. (See Figure 6.) On the other hand, relatively more of the whites were late arrivals. Compared with the Negroes, after January, 1935, proportionately, three times as many whites entered the delta area and the parish, over two and one-half as many entered the ward, and one and one-half as many occupied their present farms. Negroes, then, invariably were disproportionately concentrated among the early arrivals, conspicuously scarce among the late arrivals. In so far as time of arrival is a valid index of turnover in this instance, it shows that the Negroes of the survey area have experienced the smaller turnover.

The Persistence of New Ground Settlers. Very little, if any, of the recent settlement of the cut-over area of the delta occurred prior to 1929. Households taking up new ground holdings, for the most part then, did not replace families present in the cut-over area at the beginning of the period studied. However, there is a likelihood that some of the early new ground settlers were replaced by later ones during the ten-year interval. Some indication of the prevalence of this type of turnover is revealed by the proportion of sample new ground settlers who reported construction of their present dwelling as compared with the number merely moving into an existent dwelling. In the latter case, the supposition is that the occupants were preceded at least by the family under whose direction or for whom the dwelling was constructed. On the other hand, it is likely that the families building their present dwellings were the first occupants of the accompanying land.

The succession of different families on the new ground farms has been frequent. Three-tenths of the households on the new ground were immediately preceded in their houses by other families, and almost one-sixth moved into houses that had been vacant for more than six months.

TABLE VI. NEW GROUND HOUSEHOLDS CLASSIFIED BY RECENT DWELLING HISTORY AND RACE

DWELLING HISTORY	TOTAL		WHITE		NEGRO	
	Number	Per cent	Number	Per cent	Number	Per cent
TOTAL	145*	100.0	116	100.0	29*	100.0
Built house	77	53.1	58	50.0	19	66.0
Occupied vacant house	23	15.9	20	17.2	3	10.0
Replaced family	45	31.0	38	32.8	7	24.0

*Not ascertainable for three households.

Only slightly over one-half of the households were the first occupants of their present dwellings. (See Table VI.) This means on almost one-half of the new ground farms occupied by sample households in 1939, other families had tried to make a go and failed. One-sixth of them had remained vacant for some time awaiting other hopeful occupants.

Replacements appear to be less frequent among Negro than among white new ground households. Two-thirds of the few Negro households built their present dwellings, only one-third were preceded by other households. Correspondingly, one-half of the whites constructed their present dwellings, the other half occupied houses built by or for previous occupants. And interestingly, of the seven Negro new ground households replacing other households, six reported the former household to have been white. So the majority of the predecessors to the Negroes were white and not Negro. In contrast, only two of the 38 "replacing" white households took the places of former Negro occupants. The discovery that Negro new ground households have, to some extent, replaced white occupants may be explained by the observed tendency of Negro settlers to accept poorer locations and less adequately drained land.[26]

Motivations for Movement

A survey of the literature shows that little information of a definitive character is known concerning the entire matter of motivations for rural population movements. Investigators, for the most part, have been content to cite general situational factors that contribute to either the economic impoverishment or the enrichment of an area. Among these factors most frequently singled out are price changes, climatic changes, mechanization, depletion of crop land, the opening up of new land, and differential fertility. A painstaking analysis, however, has demonstrated "that simple generalizations, alleging uniform relationships between rural migration and conditions in the rural areas affected, are not possible."[27] Moreover, it is certain that the operation of social and psychological considerations coincidental with those of an economic nature frequently make the migration process an irrational subjective matter.

The attempt was made to approach one step nearer the problem than the mere cataloging of obvious general economic factors that were thought to, or conceivably could, have been related to the movement. This step was to obtain the migrants' own reasons for moving or their verbalizations of them.[28] Those responses of the migrants, of course, are not assumed to be consistently in accord with the conditions giving rise to their movement. Once secured the reasons were classified into one of the following categories: (1) institutional advantages; (2) attracted by relatives and friends; (3) for better land; (4) for better living quarters; (5) seeking more profitable set-up; (6) for ownership; (7) real or imagined injustices from landlord; (8) unpleasant personal associations; (9) displacement; and (10) psychological unrest.[29]

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[26] It was stated in the study by Phillip E. Jones, John E. Mason, and Joseph T. Elvove that, "Largely because the Negroes are more willing to accept the less desirable locations, their settlements are usually on the most inaccessible and the most poorly drained land . . . ." *New Settlement Problems in the Northeastern Louisiana Delta*, Louisiana Agricultural Experiment Station and Bureau of Agricultural Economics, cooperating, University, Louisiana, 1940, p. 7.

[27] C. E. Lively and Conrad Taeuber, *op. cit.*, p. 82.

[28] The migrants were asked to give the most important reason for making each move. The reason was recorded on the schedule by the enumerator.

It seemed advisable to analyze the motivations for the following types of movement: (1) from non-delta to delta area; (2) from within the delta area into the sample minor civil division; (3) to present farms; and (4) general milling about in area.

Movement from Non-Delta to Delta Area. In the ten-year period 1929-39 almost one-fourth (157) of the 660 heads of households moved from non-delta to delta area. The great majority of these left the upland hill territory of Louisiana, Arkansas, and Mississippi to farm in the level and alluvial delta area. The agricultural opportunities in this area, however, are somewhat more limited than its natural richness might indicate. At least partly as a result of the predominating large-scale plantation agriculture with its highly specialized and stratified economy, most of the doors open to migrants as well as to sedentees, lead directly to a state of virtual peonage. This situation is reflected in the general poverty of the area.[30] Consequently, it seems that, despite the prevalence of poverty and overpopulation in the areas of origin, from a rational standpoint there would be no reason for anticipating a higher level of living in the delta area despite its more fertile soil.[31]

A factor, perhaps, assuming ever-increasing importance as a magnetic influence on the non-delta as well as the delta population, is the cut-over new ground that is being sold in family-size blocks. Lively and Taeuber stated that ". . . . Rumors of the openings of good land have always brought numerous prospective settlers . . . ."[32] However, the opening of the new ground in the survey area did not bring a large proportion of the migrants directly from the non-delta area. Although one-third (53) of these migrant households were on new ground farms at the time of enumeration, only one-tenth (17) transferred in a single move from the non-delta area to the new ground farms. Settlers, regardless of point of origin, ordinarily lived on plantations in the delta prior to occupying their new farms.

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[29] These categories were devised after a thorough and systematic review of the reasons given. Their purpose is to enable brief statistical statements and comparisons that would have been impossible had the reasons been left in their original form for the analysis.

[30] Mangus observed that "The rural-farm plane of living is lower than in any other major region. Only the favored few have houses whose value approaches the United States average, and the possession of such conveniences as telephone, running water, electric lights, automobiles, and radios is very limited." *Op. cit.*, p. 22.

[31] Pertinent in this respect is the finding of Dorothy Dickins that Negro farm families in the poor hill section of Mississippi were living at a higher material level than those in the fertile delta area. *Family Living on Poorer and Better Soil,* Mississippi Agricultural Experiment Station Bulletin 320, State College, 1937, pp. 35-36.

[32] C. E. Lively and Conrad Taeuber, *op. cit.*, p. 66.

In spite of the limited economic opportunity of the delta area, the heads of the migrant households most frequently gave as the reason primarily responsible for the transfer "the desire for a more profitable set-up." One-third of all reported this reason. (See Table VII.) One-fourth gave the reason of next importance—getting close to relatives and friends. Approximately one-sixth reported that each, the desire for better land and the pressure of displacement, was the primary motivating force bringing about their move into the delta. Other reasons were only infrequently given. It is perhaps significant, since this was primarily a farm to farm transfer, that only three families moved seeking ownership. Racial comparisons are hindered by the small number of Negroes among the migrant households. However, proportionately, heads of four times as many white as Negro households reported their move to be the consequence of a desire for better land.

Movement from Within Delta to Sample Minor Civil Division. Almost one-third (211) of the heads of the 660 sample households entered the minor civil division from delta territory between 1929 and 1939. By and large the same reasons that stood out as the more determinative for the transfer from non-delta to delta territory were more frequently cited as the cause for this move into the minor civil division. (See Table VIII.) Approximately one-fifth of the heads of these moving households attributed this change of residence to a more profitable set-up, one-fifth to drawing power of friends and relatives, and over one-sixth to being forced off former place.

However, the smaller emphasis put on the profit motive (including better land) and the greater emphasis placed on living quarters, injustices of landlord, and unpleasant personal associations by the intra-delta migrants may reflect the philosophy engendered by the prevailing social and economic system. Perhaps experience has persuaded many that the most tangible rewards obtainable for their labor are satisfactory living quarters and pleasant personal relations. The upsurge of ownership as a cause for this type of intra-delta movement results from the opportunity offered after 1935 by the sale of the cut-over new ground in family-size holdings.

Clear-cut differentials are evident between the expressed reasons for moving of the whites and Negroes. For the move into the sample ward, as was the case for the move into the delta area, "relatives and friends" were relatively more often cited by the heads of Negro households as a cause for moving. Also of more importance for the Negroes were "better living quarters" and "injustices of landlord." The whites, on the contrary, attributed this move proportionately over five times more frequently to the quest for better land and over seven times more frequently to the quest for ownership. Although, traditionally, ownership has been closed

TABLE VII. REASONS GIVEN FOR MOVING, 1929-1939, CLASSIFIED BY RACE OF HOUSEHOLD AND TYPE OF MOVEMENT

REASONS FOR MOVING	MOVEMENT INTO DELTA			MOVEMENT FROM OTHER DELTA AREA INTO WARD			MOVEMENT TO PRESENT FARMS			ALL RESIDENTIAL CHANGES WITHIN DELTA AREA		
	Total	White	Negro	Total	White	Negro	Total	White	Negro	Total	White	Negro
Number	148	109[1]	39[2]	202	90[3]	112[4]	541	240[5]	301[6]	1195	610	585
Per cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Displacement	17.6	19.3	13.0	18.3	17.0	19.6	19.8	18.7	20.6	24.3	26.1	22.4
More profitable set-up	32.4	32.1	33.0	23.8	21.0	25.9	22.2	19.2	24.6	23.8	25.4	22.2
Relatives and friends	25.0	20.2	38.0	20.8	16.0	25.1	13.3	11.7	14.6	11.5	9.8	13.2
Better living quarters	.7	.9	....	5.9	4.0	7.1	14.4	12.1	16.2	10.8	7.0	14.7
Ownership	2.0	1.8	3.0	9.9	19.0	2.6	13.9	24.1	5.6	7.1	10.7	3.4
Psychological unrest	3.4	3.7	3.0	2.0	2.0	1.8	3.2	2.1	4.0	6.9	5.4	8.4
Injustices of landlord	.7	....	3.0	5.0	2.0	7.1	1.8	1.7	2.0	6.3	4.6	8.2
Better land	16.2	20.2	5.0	5.4	10.0	1.8	3.3	6.7	.7	4.5	7.7	1.2
Personal associations	....	....	....	7.9	8.0	8.0	7.4	2.9	11.0	3.1	1.3	4.9
Institutional advantages	2.0	1.8	3.0	1.0	1.0	1.0	.7	11.7	14.6	1.7	2.0	1.4

[1] Reason for 3 white households not ascertainable.
[2] Reason for 6 Negro households not ascertainable.
[3] Reason for 1 white household not ascertainable.
[4] Reason for 8 Negro households not ascertainable.
[5] Reason for 1 White household not ascertainable.
[6] Reason for 8 Negro households not ascertainable.

TABLE VIII. HOUSEHOLDS IN EACH OF THE THREE RESIDENTIAL CATEGORIES CLASSIFIED BY SIZE AND RACE

NUMBER OF PERSONS IN HOUSEHOLD	TOTAL		WITHIN WARD		WITHIN DELTA		INTO DELTA	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Total								
TOTAL	660	100.0	292	100.0	211	100.0	157	100.0
One	48	7.3	31	10.6	11	5.2	6	3.8
Two	170	25.8	99	33.9	49	23.2	22	14.0
Three	113	17.1	49	16.8	38	18.0	26	16.6
Four	92	13.9	33	11.3	37	17.5	22	14.0
Five and over	237	35.9	80	27.4	76	36.1	81	51.6
White								
TOTAL	250	100.0	47	100.0	91	100.0	112	100.0
One	8	3.2	1	2.0	4	4.0	3	2.7
Two	28	11.2	13	27.0	8	9.0	7	6.2
Three	43	17.2	6	13.0	18	20.0	19	16.9
Four	44	17.6	8	17.0	19	21.0	17	15.2
Five and over	127	50.8	19	41.0	42	46.0	66	59.0
Negro								
TOTAL	410	100.0	245	100.0	120	100.0	45	100.0
One	40	9.7	30	12.3	7	5.8	3	7.0
Two	142	34.6	86	35.1	41	34.2	15	33.0
Three	70	17.1	43	17.6	20	16.7	7	16.0
Four	48	11.7	25	10.2	18	15.0	5	11.0
Five and over	110	26.9	61	24.8	34	28.3	15	33.0

to all except the favored few in the delta area, this has been especially the case for Negroes. Now, even with the current land rush in progress, the Negro, for one reason or another, continues on the whole to remain apart from ownership. This accounts for the relative lack of ownership reasons for moving given by Negroes.

Movement to Present Farm. The heads of 550 households moved to the farms on which they were enumerated between 1929 and 1939. Considerably more than one-fifth of these attributed this particular shift to the desire for a more profitable set-up. (See Table IX.) An additional one-fifth stated displacement at their former residence was the cause for their last move. Next in order are three reasons of about the same importance: the desire for better living quarters, ownership, and the attraction of relatives and friends. Each of these reasons was cited by over one-eighth of the heads of households. It seems that as the typical short-distance delta

TABLE IX. HEADS OF HOUSEHOLDS AND WIVES IN EACH OF THE THREE RESIDENTIAL CATEGORIES, CLASSIFIED BY YEARS OF SCHOOLING COMPLETED AND BY RACE.

YEARS OF SCHOOLING COMPLETED	HEADS OF HOUSEHOLDS				WIVES OF HEADS			
	TOTAL	Within ward	Within delta	Into delta	TOTAL	Within ward	Within delta	Into delta
Total number	630	283	200	147	505	203	167	135
Per cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
None	14.3	18.7	12.0	8.9	9.9	13.3	8.4	6.7
1-3	26.6	33.6	26.0	13.6	17.0	22.6	18.0	7.4
4-6	35.0	31.1	39.5	36.7	39.2	40.5	39.5	37.1
7-10	20.8	13.7	20.0	35.3	29.5	18.6	32.1	42.2
11 and over	3.3	2.9	2.5	5.5	4.4	5.0	1.8	6.6
Total number: White	241	46	90	105	218	42	78	98
Per cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
None	5.0	2.0	3.0	7.6	4.1	7.0	3.0	4.0
1-3	11.7	11.0	17.0	7.6	5.5	7.0	8.0	3.0
4-6	37.3	33.0	46.0	32.4	34.9	24.0	37.0	38.0
7-10	38.2	39.0	30.0	44.7	47.2	43.0	51.0	46.0
11 and over	7.8	15.0	4.0	7.7	8.3	19.0	1.0	9.0
Total number: Negro	389	237	110	42	287	161	89	37
Per cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
None	20.1	21.9	19.1	12.0	14.3	14.9	13.0	14.0
1-3	35.8	38.0	33.7	29.0	25.7	26.7	27.0	19.0
4-6	33.7	30.8	34.5	47.0	42.6	44.8	42.0	35.0
7-10	10.0	8.9	11.8	12.0	16.0	12.4	16.0	32.0
11 and over	.4	.4	.9	....	1.4	1.2	2.0	....

move is approached, living quarters command a greater consideration, relatives and friends a smaller consideration, as legitimate causes for moving.

Another distinguishing feature of the reasons given for the move to present farms is importance of ownership. Largely responsible for the frequency of this reason is the opportunity for ownership provided by the opening and sale of the cut-over new ground in family-size parcels. This ownership reason was very rarely given for the move to plantations, but it accounted for two-fifths of the moves to the family-size farm units. Moreover, approximately the same proportion of Negroes and whites moving to the new ground reported ownership as the primary cause. However, since Negroes were outnumbered by four to one on the new ground farms, the small number of all Negro households giving the ownership reason is understandable.

General Milling About in Delta Area. It is well established that the great bulk of residential changes made in rural areas are confined within relatively small spatial limits despite the general prevalence of this milling phenomenon, it is perhaps more conspicuously present in the Mississippi delta area than in any other rural region.[33] The fabulous extent of such moving about from farm to farm in the delta was indicated in the section on "turnover." The median length of residence on present farms was found to be only 1.4 years for whites and 3.4 years for Negroes.

The situational factors primarily responsible for this continual milling about in the delta, for the most part, seems to be inherent in the prevailing order of large-scale agriculture.[34] ". . . . In those parts of the United States where the plantation system has been the dominant agricultural institution, the share-wage labor system has generated a tremendous amount of shifting from one plantation to another."[35] Vance contends that eventually many farm families become habituated to this continual change of residence.[36] It is further suggested by Lively and Taeuber that this "shifting about at the same occupational level becomes a substitute for movement up the agricultural ladder."[37] From these considerations it appears evident that the farm population of the Mississippi delta area has developed a tradition of residential instability. The great frequency of moves perhaps has made them relatively normal and expected.

The usual readiness of an explanation for a majority of the farm to farm moves occurring within the area may indicate not so much that these moves are executed without cause as that more and slighter causes constitute adequate pretexts for moving. Reasons for 1,195 residence shifts within the delta were reported by the total sample. Displacement at previous residence allegedly accounted for one-fourth (290) of these moves, the greatest number in any single category. (See Table X.) Next, and of the same approximate importance as displacement, was the desire for a more profitable set-up. Then, in order of frequency reported, came the two reasons, attraction of relatives and friends and the desire for better living quarters. Over one-tenth of the moves were attributed to each of these reasons. The remaining reasons were cited less frequently. Heads of Negro households had made less than one-half of these moves, although they comprised over three-fifths of the total sample. Furthermore, the reasons for the moves reported by the Negroes appear to differ significantly from those reported by the whites. Briefly, the differences suggest that either the white households of the delta area are more frequently motivated to move by circumstances ordinarily assumed to be largely economic in character or they are more often inclined to justify their residential changes by economic rationalizations.

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[33] T. Lynn Smith designated "the annual movement of Southern croppers and 'tenants' from one plantation to another" as an outstanding example of farm to farm mobility. *The Sociology of Rural Life,* p. 189.

[34] P. A. Sorokin and Carle C. Zimmerman have summarized the reasons for the predominance of short-distance moves in *Principles of Rural-Urban Sociology,* New York: Henry Holt and Company, 1929, pp. 593-594. These reasons are of general application and are thus basic to the more local situational factors cited in the text as being partially responsible for short-distance moves in the delta area.

[35] T. Lynn Smith, *The Sociology of Rural Life,* p. 191. Also see T. Lynn Smith, "Characteristics of Migrants," *The Southwestern Social Science Quarterly,* (March, 1941), p. 338. T. J. Woofter likewise views the prevailing agricultural system as primarily responsible for the farm-to-farm moves. *Op cit.,* p. 107.

[36] Rupert B. Vance, *Human Factors in Cotton Culture,* Chapel Hill: University of North Carolina Press, 1929, pp. 134-35, 308. A similar conclusion was reached by Max R. White, Douglas Ensminger, and Cecil L. Gregory. "Being on the move becomes a part of their pattern of life with frequent changes of residence from one community to another the rule, rather than the exception." *Op. cit.,* p. 4.

[37] C. E. Lively and Conrad Taeuber, *Op. cit.,* p. 124.

TABLE X. TOTAL YEARS SPENT IN AGRICULTURE BY THE HEADS OF HOUSEHOLDS IN EACH OF THE THREE RESIDENTIAL CATEGORIES, 1929-1939, CLASSIFIED BY TENURE STATUS AND RACE

TENURE STATUS	TOTAL		WITHIN WARD		WITHIN DELTA		INTO DELTA	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Total								
TOTAL	5,561	100.0	2,543	100.0	1,791	100.0	1,227	100.0
Owner	886	16.0	501	19.7	158	8.8	227	18.5
Tenant	802	14.4	379	14.9	264	14.7	159	13.0
Cropper	2,227	40.0	917	36.0	798	44.6	512	41.7
Laborer	1,646	29.6	746	29.4	571	31.9	329	26.8
White								
TOTAL	2,010	100.0	402	100.0	774	100.0	834	100.0
Owner	534	26.6	188	46.8	129	16.7	217	26.0
Tenant	453	22.5	75	18.6	239	30.9	139	16.7
Cropper	727	36.2	105	26.1	308	39.8	314	37.6
Laborer	296	14.7	34	8.5	98	12.6	164	19.7
Negro								
TOTAL	3,551	100.0	2,141	100.0	1,017	100.0	393	100.0
Owner	352	9.9	313	14.6	29	2.8	10	2.5
Tenant	349	9.8	304	14.2	25	2.5	20	5.1
Cropper	1,500	42.3	812	37.9	490	48.2	198	50.4
Laborer	1,350	38.0	712	33.3	473	46.5	165	42.0

PART III

MIGRATION DIFFERENTIALS

Migrants ordinarily differ in many respects from non-migrant or sedentary persons. The quantitative and qualitative extent of the differences has extreme significance for the area of destination as well as the area of origin. The vital consequence to an area of receiving or sending disproportionate numbers of migrants of a particular social, economic, or demographic status is well known. In view of this, migration assumes a much broader and deeper meaning than if its only result were a net change of total population. Indeed through the operation of these differentials, the entire physiognomy of a population may be altered by coexisting in and out currents of migration that effect little or no net change in the total number.

Since this is a study of migration into an area, the problem of differentials is necessarily approached by comparing the characteristics of the entering and the sedentary populations, classified into three groups in this study. The three residential groups are compared to ascertain whether they differ in the following basic respects: (1) age distribution; (2) family composition; (3) education; (4) occupation; and (5) levels of living.

Age Composition

Young adults are included in greater proportions among migrating than among non-migrating populations. The "sculpturing" effects of this differential on the populations both sending and receiving migrants are generally recognized. In turn the age structures of the respective populations exert a vital influence on the social and economic potentialities of the areas of origin and destination.[38] The usual immobility of the very young and the aged means that productive capacity of an area tends to vary inversely and the degree of dependency directly with the net losses sustained through migration. In addition to the economic effects, the operation of age differentials in migration gives rise to significant institutional repercussions.

Total Populations of the Three Residential Categories. In the main, the migrant families (i.e., those entering the sample minor civil division), as compared with the sedentary households, include a disproportionately large share of young adults. (See Figure 7.) These differentials may be generally stated in terms of three broad age groupings, under 15 or children, 15-45 or the more productive years, and 45 and over or the years of declining productivity. The persons included in the sedentary households were relatively concentrated in the ages above 45 and particularly so in the ages above 55. At the same time, these immobile persons, compared with the individuals of the two migrant groups, had comparatively few members under 15 years of age, as well as in the intermediate age group, 15-45. However, the relative deficiency of the sedentees in this latter group seemed to result for the most part from the extremely large number of young adults, aged 20-30, in the migrant groups. This concentration of adults at the most fertile years of life in the migrant groups is responsible for their inclusion of a comparative excess of children.

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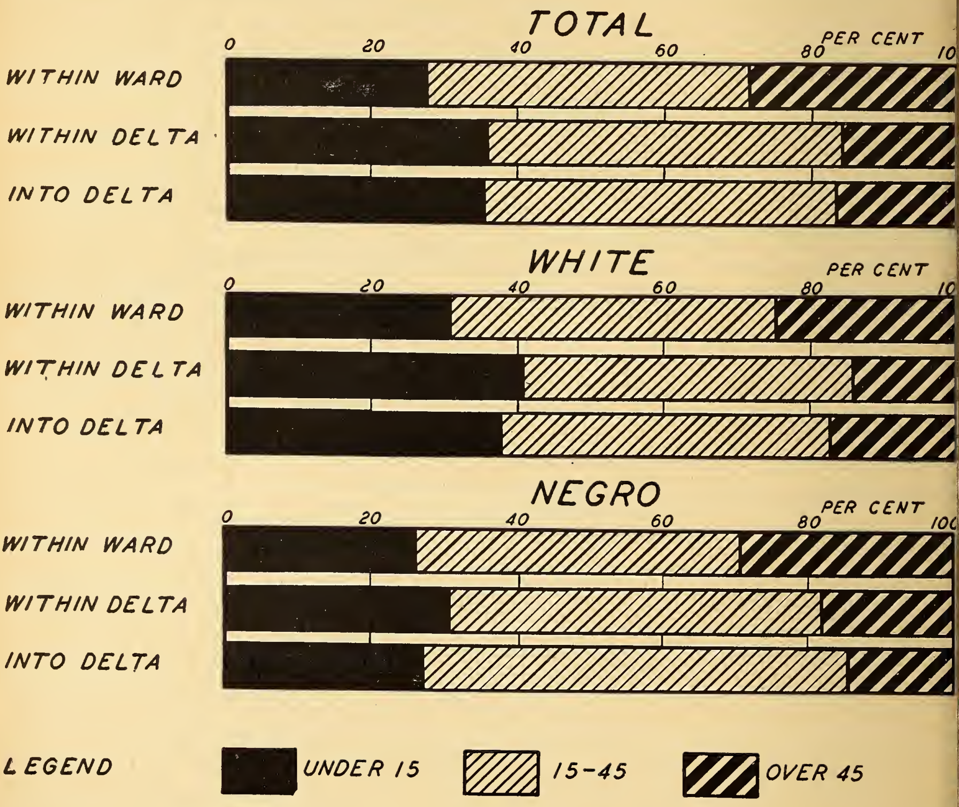
[38] Cf. T. Lynn Smith's statement, "The age distribution is one of the most significant and informing categories of information that can be secured concerning any population. One of the first tasks of migration studies should be to set forth the significant features concerning the distribution of ages in the migrant population." "Characteristics of Migrants," p. 7. Also see T. Lynn Smith, *The Sociology of Rural Life,* p. 71.



GURE 7. Percentage Age Distributions of the Persons Included in the Three Residential Categories, by R

These major age differences between migrant and non-migrant persons hold irrespective of race. However, the age structures of the two migrant groups also differ somewhat from each other. Generally speaking, the adult persons from outside the delta area were less frequently included in the young fertile age class, and consequently had relatively fewer children under five.

Heads of Households of the Three Residential Categories. In accord with these age findings for the total populations, the heads of the immobile households, as a group are oldest; the heads of the households from non-delta territory, intermediate; and the heads of the households moving about within the delta area, youngest. Specifically, the median ages of these groups were 47.8, 42.7, and 38.3 years, respectively. This indicates that the survey area more frequently received families with youthful heads from within than from without the delta area, although the heads of both groups of migrant families were significantly younger than those of the immobile families remaining within the ward. Thus, for the sample area, a net in-migration of these families means, in addition to the numerical change of population, more workers in the productive ages. However, the concomitant increase of dependent children somewhat counterbalances the salient effect of the relative absence of aged dependents. The children represent additional burdens for the school resources of the area. And the young adults, if they remain in the area, perhaps will serve as a source of more children in the future.

Family Composition

Type of Family. The households migrating into and within the delta area differ significantly in type from the immobile households. Families composed of "husband, wife, and children only" were more often included in each of the migrant groups than in the non-migrant group. (See Figure 8.) This generalization is applicable to both races. Moreover, in both the Negro and the white samples, a larger proportion of the migrant households into the delta than within the delta area were of this type. For example, of the total sample, five-eighths of the households moving into the delta, almost one-half of the households migrating within the delta, and only one-fourth of the households remaining within the ward included husband, wife, and children only. Beyond this point of general consensus, the white and Negro families of the sample were unlike.

Size of Household. The sizes of the households included in the three residential categories are not unrelated to the age and family-type factors already analyzed. From the standpoint of age, the relative concentration of both the young adult and the children's groupings in the migrant households and from the standpoint of family type, the greater frequency of the husband, wife, and children family in the migrant categories point to comparatively larger mobile than immobile households. (See Table VIII.) The small-sized families were relatively more numerous in the

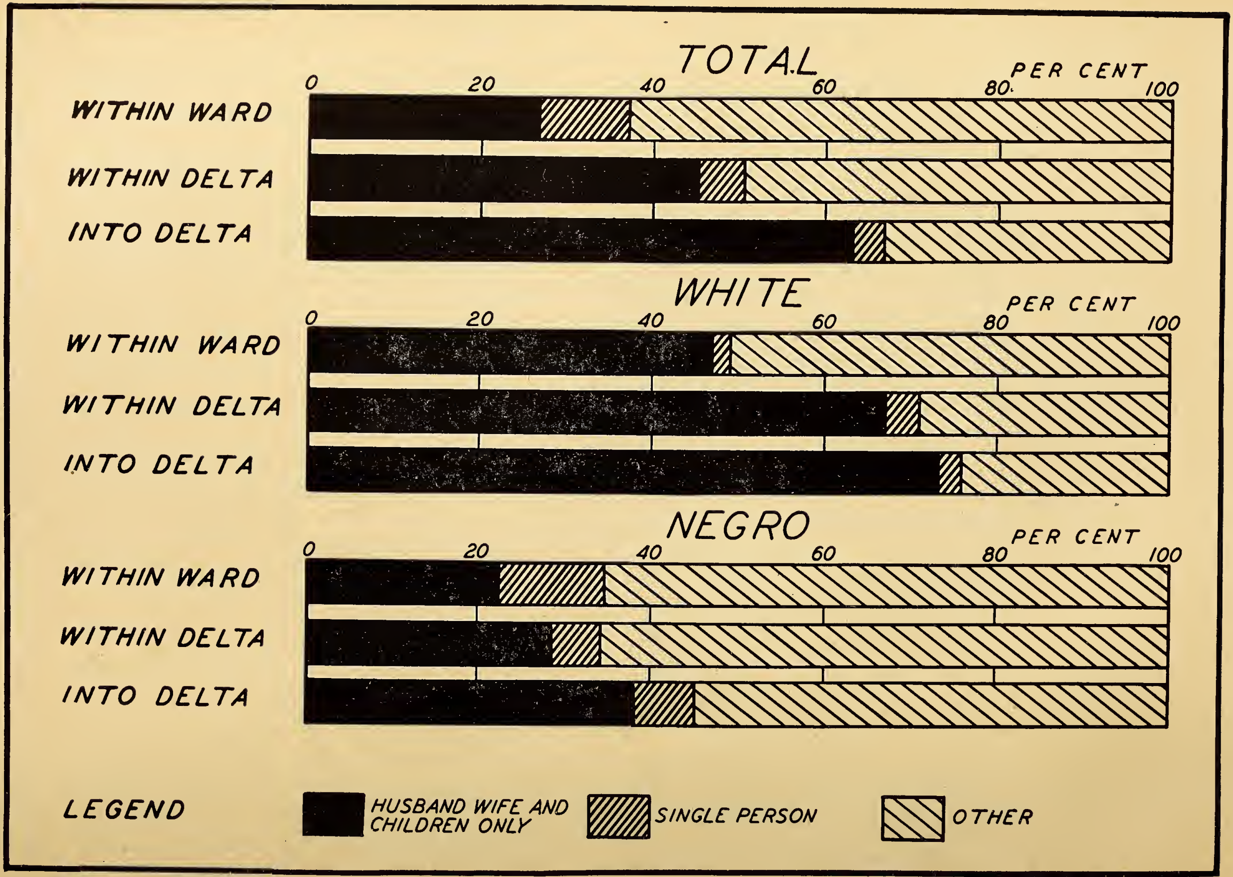


FIGURE 8. Types of Families Making Up the Three Residential Categories, by Race.

immobile group, slightly larger families seemed more typical of the "within-delta" migration, and the very large families were most often included in the movement from non-delta territory.

The Negro and white households of the sample differ markedly from each other in size. In all cases the Negro households were substantially smaller than the white households. One- and two-member households were proportionately over three times more numerous in the total Negro sample. Moreover, whereas one-half of all white households were composed of five or more persons, this was the case for only one-fourth of the Negro households. The median number of persons in the total households was 4.0; the median numbers for the white and Negro households were 5.1 and 3.3, respectively. Similar differences were apparent in each of the three residential categories. The fewer persons included in the Negro households is in accord with the strikingly low fertility characterizing the Negroes of the delta area immediately adjacent to the Mississippi River.[39] Other factors, as a higher death rate, are doubtlessly also associated with the smaller Negro households.

Despite this prevailing racial difference, the size of households seems to bear the same general relationship to migration among both the whites and Negroes. The larger Negro households, like the larger white households, were relatively least numerous in the immobile group, and most numerous in the migrant group from non-delta territory. Two-fifths of the white households remaining within the ward compared with almost one-half of the households moving about within the delta and three-fifths of the households migrating into the delta included five or more persons. Among the Negroes, corresponding, though smaller proportions of the three residential groups of households were of this size.

These marked size and type of family differences among the three residential categories result partially from their dissimilar age structures. In addition, the inclusion of the largest number of persons in the households from non-delta territory is perhaps related to the previous residence of the majority of them in the neighboring upland hill section which is characterized by higher fertility and large families. Notwithstanding the differences between the households from within and without the delta, the fact remains that they both were significantly larger than the immobile households remaining within the ward. A net gain of these larger households by the survey area has likely had the effect of increasing the total population more rapidly than the number of families or, in other words, of increasing the average size of family in the area.

Education

Several studies have analyzed the educational differences, usually in terms of grades completed, between migrant and non-migrant persons. For the most part these studies have been concerned only with rural-urban migration. The general consensus is that "migrants to towns and cities receive more formal educational training than the sedentees."[40] However, little is known of the relative educational achievements of the persons moving in other currents of migration. This study analyzes the educational levels of the participants in the predominantly rural-farm migration into and within the Mississippi delta and compares these levels with those attained by the sedentary population.

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[39] Conrad Taeuber and Irene B. Taeuber, "Negro Rural Fertility Ratios in the Mississippi Delta," *The Southwestern Social Science Quarterly*, Vol. 21 (December, 1940), pp. 210-220.

Grades Completed by Heads of Households. The heads of the sample households, on the whole, are characterized by low educational attainment. (See Table IX.) Less than one-fourth had advanced beyond the seventh grade and one-seventh reported no formal schooling. These proportions, of course, reflect the depressing effect of the low level of education in the Negro segment of the sample.

The heads of the Negro and white households, as would be expected, varied widely from each other in amount of formal education received. Proportionately, four times as many of the former as of the latter reported no schooling whatever. On the other hand, over four times as many of the whites as the Negroes had completed the seventh or a higher grade. This striking difference between the races in educational status is also demonstrated by the fact that less than one-half of the heads of the Negro households had completed the fourth or a higher grade as contrasted with five-sixths of the heads of white households. The causes for this markedly inferior educational status of the Negro are perhaps as numerous and complex as the aspects of race relations.

In addition to the differences between whites and Negroes, the three residential categories within each racial group exhibited divergent educational patterns. The heads of the immobile Negro households had received the least formal training, the heads of the migrant households from non-delta territory had received the most. Between these extremes was the status of the heads of the households moving within the delta area. Unlike this educational pattern, the heads of the white households remaining within the ward included relatively the fewest representatives entirely without formal education and the most with at least a high school education. On the whole, then, the educational level of this white immobile group was as high as that of the migrant group fron non-delta territory. The residence groups moving within the delta exhibited the lowest status of all among the whites.

Grades Completed by Wives of Heads of Households. The wives, in the main, receive more formal schooling than their husbands. (See Table IX.) Fewer of the wives reported no schooling at all and significantly more of them completed the seventh or a higher grade. However, residential patterns of education characterizing the wives of the two racial groups are strikingly similar to those exhibited by their respective husbands. This perhaps is the result of assortative mating on the part of both the migrant and the sedentary heads. Among the Negroes the wives entering the delta area, as did their husbands, included the most representatives having completed the seventh or a higher grade whereas the wives remaining within the ward included the fewest of this type. The proportion of wives moving within the delta of this educational class was intermediate. The white wives remaining within the ward, in contrast to the Negro wives but similar to the heads of white households as a group, attained an educational status equal or superior to that of the wives entering the delta area. And, as in the case of the corresponding white husbands, the wives migrating within the delta on the whole attended school the fewest years.

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[40] T. Lynn Smith, "Characteristics of Migrants," *op. cit.*, p. 348.

The striking parallel between the heads of households and their wives with respect to educational status would appear to support the hypothesis that the highly stratified society of the delta area, although permitting members of a few favored immobile white households to complete relatively large amounts of schooling, militates against the general acquisition of a high level of formal education.[41] The inclusion of only a few representatives of the privileged class among the white immobile households may explain the higher average educational level for husbands and wives of this group. The fact that the persons moving within the delta were, for the most part, both exclusive of the favored class and possessed of relatively few years of formal education, would seem to reflect this situation. Both the heads of households and their wives who moved about within the delta had received fewer years of schooling than the corresponding persons from non-delta territory. However, whatever may have been the cause, the findings seem fairly well supported that regardless of race the heads of households and their wives from non-delta territory had attended school longer than the heads moving about within the delta area. Also, for the Negro sample, the heads of households and their wives from the non-delta territory were superior in educational status to the corresponding immobile persons.

Occupation

The importance of occupational differentials in the field of migration largely rests on the extent to which migration is accompanied by change of occupation and the extent to which the migrants' occupations differ from those of the settled population at the point of destination.[42] The primary consideration in the former case is whether the migrant retrogressed or advanced occupationally as a result of the migration. In the latter case, the central question concerns the success attending the occupational effort of the migrant as compared to that of the resident in the area of destination. Both of these aspects of occupational differentials as

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[41] Cf. T. Lynn Smith's statement, ". . . . it should be remembered that education of the masses is hardly considered an asset where caste is strong and agriculture is large scale." *The Sociology of Rural Life,* p. 380.

[42] Cf. Dorothy Swaine Thomas, *Research Memorandum on Migration Differentials,* p. 126.

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well as the association of tenure status and mobility are analyzed with reference to the migration into the rural-farm portion of the sample minor civil division.

Tenure Status and Mobility. An occupational analysis of rural-farm residents is, for the most part, concerned with the difference in tenure status. Significant interrelationships between tenure status and mobility have been observed in all rural regions of the United States. Each advance of tenure status in the direction of ownership tends to exert a stabilizing influence on residence.[43]

In order to determine the nature of the generally recognized association between mobility and tenure status for the recent migration into the survey area, the total years spent in agriculture, 1930-39, by the heads of the households comprising the three residential categories were classified according to tenure class and race. (See Table X.) The largest proportion of man-years (two-fifths) for the total sample was spent at the cropper level. Next in importance was the laborer status, at which level three-tenths of the total man-years were spent. The heads of the households had been in the owner class over one-sixth of their years in agriculture since 1930, and in the tenant class the remaining (one-seventh) years.

Despite the relatively inferior tenure levels of the Negro, as compared with the white, a clear-cut association between mobility and tenure status was conspicuously evident for each of the racial groups. The heads of the migrant households, both white and Negro had remained proportionately more years in the cropper and laborer classes and fewer years in the owner class than had been the case for the heads of the immobile households. (See Table X.) Among the heads of the white households, for example, almost one-half of the total years spent in agriculture since 1930 by the immobile group had been at the owner level as compared with one-sixth of the years spent by the group moving within the delta and with one-fourth of the years by the households entering the delta. On the other hand, the proportions of years in cropper and laborer classes combined for these three residential groups were one-third, one-half, and almost three-fifths, respectively. The younger age of the heads of the migrant households should not be overlooked as a factor partly responsible for the relatively few years they have accumulated as owners.

Present Tenure Status. The relative success attending the occupational efforts of the migrants in the area of destination is of fundamental importance. The comparison of the tenure distribution of the heads of households included in three residential categories who are primarily engaged in agriculture reveals how the migrants have fared occupationally with the residents. (See Table XI.) At the time of the survey in 1939 over one-third of the heads of households in agriculture were classed as day laborers. Approximately one-fourth were included in each of the two groups, owners and croppers. The balance of the agriculturists were in the tenant group, the smallest tenure class.

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[43] T. J. Woofter, Jr., *Landlord and Tenant on the Cotton Plantation,* p. 110; T. Lynn Smith, *The Sociology of Rural Life,* p. 189.

Negroes, as a group, occupy a lower tenure status than whites. Owners were proportionately three times more numerous among the whites than among the Negroes. In contrast, the Negro sample included proportionately three times as many day laborers and significantly more croppers. Moreover, a widening of this tenure status difference is inevitable since the predominant settlement of whites on the owner-operated new ground farms means a disproportionate increase of white owners.

TABLE XI. HEADS OF HOUSEHOLDS IN AGRICULTURE IN EACH OF THE THREE RESIDENTIAL CATEGORIES, CLASSIFIED BY TENURE STATUS AND RACE

TENURE STATUS 1939 (if in agriculture)	TOTAL		WITHIN WARD		WITHIN DELTA		INTO DELTA	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
				Total				
TOTAL	614	100.0	273	100.0	200	100.0	141	100.0
Owner	157	25.6	71	26.0	39	19.5	47	33.3
Tenant	82	13.4	34	12.5	29	14.5	19	13.5
Cropper	161	26.2	73	26.7	57	28.5	31	22.0
Laborer	214	34.8	95	34.8	75	37.5	44	31.2
				White				
TOTAL	226	100.0	43	100.0	85	100.0	98	100.0
Owner	101	44.7	24	56.0	33	39.0	44	45.0
Tenant	46	20.3	5	11.0	23	27.0	18	18.0
Cropper	45	19.9	8	19.0	18	21.0	19	20.0
Laborer	34	15.1	6	14.0	11	13.0	17	17.0
				Negro				
TOTAL	388	100.0	230	100.0	115	100.0	43	100.0
Owner	56	14.4	47	20.4	6	5.2	3	7.0
Tenant	36	9.3	29	12.6	6	5.2	1	2.0
Cropper	116	29.9	65	28.3	39	33.9	12	28.0
Laborer	180	46.4	89	38.7	64	55.7	27	63.0

The heads of the two groups of migrant households, on the whole, had not climbed to a tenure level equal to that of the heads of resident households by 1939. (See Table XI.) For both whites and Negroes, the heads of the resident households were at the highest level. This would seem more likely to indicate that owners are less mobile than that immobile persons more frequently become owners. However, the two groups of white migrants, particularly where contrasted with the Negro migrants, included large proportions of owners in 1939. Unquestionably, this large number of owners reported among the heads of the white entering households is not a part of traditional plantation agriculture, but for the most part, a result of the recently created settlement opportunities.

Change in Tenure Status. Excessive mobility among farmers has been deplored because of its many undesirable social and economic concomitants. Despite this, Woofter has pointed out that "excessive stability may also prove to be harmful to individual farmer and to society."[44] Among other social functions, mobility expedites movements up the agricultural ladder. Ordinarily, one or more farm-to-farm transfers has to be made by a given operator in the climbing process.

However, that mobility has served in such a capacity in the delta area is generally doubted.[45] In the first place, the mobility actually occurring has greatly exceeded any hypothetical optimum. In the second place, the agricultural ladder, largely incompatible with the plantation economy, obviously has been operative only to a slight degree, if at all. The traditional plantation situation, however, has been upset by the current sale and settlement of cut-over new ground in family-size parcels. Hundreds of families taking advantage of these new ground opportunities in the delta area already are boasting at least the guise of ownership.

In view of such considerations it is significant to know what tenure changes accompanied the territorial movements of the sample households as well as the role of type of operating unit in effecting these changes. Furthermore, it is important to ascertain the corresponding tenure changes made by the heads of the immobile households in the same period. These points are clarified by presenting the tenure distributions of the agriculturists of the three residential categories at three separate times in the ten-year study interval, 1929, 1934, and 1939. A comparison of the proportionate importance of the tenure classes of a given residential category at these three times will divulge, in a general way, the direction and extent of tenure changes characterizing the sample heads of households.

Significant changes in tenure were made by the heads of households engaged in agriculture during the ten-year period. (See Table XII.) Less than one-tenth of all were owners in 1929, one-seventh in 1934, and one-fourth in 1939. The especially rapid increase in ownership between 1934 and 1939 reflects the settlement of the new ground farms. Thus, proportionately, the number of owners in the total sample increased approximately two and one-half times in the decade. At the same time, the tenant class showed only a slight decrease and the cropper group experienced a substantial loss, including two-fifths of all heads of households in 1929 and slightly over one-fourth of them in 1939. The fact that the laborer class was slightly larger in 1939 than could be accounted for

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[44] T. J. Woofter, *Landlord and Tenant on the Cotton Plantation,* p. 108.

[45] T. Lynn Smith, *The Sociology of Rural Life,* p. 191, and T. J. Woofter, Jr., *Landlord and Tenant on the Cotton Plantation,* pp. 107 ff.

TABLE XII. THE HEADS OF HOUSEHOLDS IN EACH OF THE THREE RESIDENTIAL CATEGORIES CLASSIFIED BY TENURE STATUS, 1929, 1934, AND 1939, AND RACE

TENURE STATUS (if in agriculture)	TOTAL			WITHIN WARD			WITHIN DELTA			INTO DELTA		
	1929	1934	1939	1929	1934	1939	1929	1934	1939	1929	1934	1939
Total												
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Owner	9.2	13.9	25.6	14.2	19.0	26.0	1.1	6.3	19.5	10.1	14.0	33.3
Tenant	16.0	15.2	13.4	16.4	13.9	12.5	16.1	15.8	14.5	15.1	17.0	13.5
Cropper	39.7	38.5	26.2	38.5	34.1	26.7	46.7	42.1	28.5	31.9	42.6	22.0
Laborer	31.6	30.7	28.7	31.9	34.8	33.9	34.7	37.5	37.5	34.5	22.5	31.2
At home	3.5	1.7	....	2.2	1.1	....	2.2	1.1	....	8.4	3.9	....
White												
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Owner	13.2	23.0	44.7	28.6	51.2	55.8	2.6	11.6	38.8	15.2	19.3	44.9
Tenant	28.4	25.3	20.3	31.0	16.3	11.6	35.5	33.3	27.0	20.2	22.7	18.4
Cropper	33.5	36.4	19.9	31.0	23.3	18.6	39.5	41.0	21.2	29.1	38.6	19.4
Laborer	18.8	12.4	15.1	2.3	4.6	14.0	19.8	14.1	13.0	26.6	14.8	17.3
At home	6.1	2.9	....	7.1	4.6	....	2.6	0.0	....	8.9	4.6	....
Negro												
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Owner	7.2	8.9	14.4	11.6	13.0	20.4	0.0	2.7	5.2	0.0	2.4	7.0
Tenant	9.5	9.7	9.3	13.7	13.5	12.6	1.9	3.6	5.2	5.0	4.9	2.3
Cropper	43.0	39.7	29.9	39.9	36.1	28.3	51.9	42.8	33.9	37.5	51.3	27.9
Laborer	38.2	40.7	46.4	33.5	37.0	38.7	44.3	49.1	55.7	50.0	39.0	62.8
At home	2.1	1.0	....	1.3	.4	....	1.9	1.8	....	7.5	2.4	....

through heads of households leaving their parental homes indicates some backward movement on the agricultural ladder. Regardless of the extent of this retrogression, it is apparent from the continued importance of the laborer class that the agricultural ladder did not serve as a climbing mechanism for a considerable number of heads of households. Unfortunately, this tabulation shows only the net effect of all changes on the total tenure structure and not the number and direction of individual shifts.

The nature of the tenure changes made seem to vary somewhat among the three residential categories. The proportion of owners included in the white immobile group doubled, the proportion in the group moving within the delta area increased fifteen fold, and the proportion included in the group from non-delta territory trebled. Despite the tremendous multiplication of owners among the heads of households moving about within the delta, this group had relatively the fewest owners in 1939. This increase is explained by the extreme sparseness of owners in the group in 1929. On the other hand, although the number of white immobile owners only doubled, the smallest increase, this group was characterized by the largest relative number of owners in 1939. Moreover, among the whites, the proportion of laborers and croppers of the two migrant groups decreased substantially, whereas these two tenure classes combined held their own among the immobile heads of households. Thus, notwithstanding the relative inferior tenure ranking of the heads of the two groups of white migrant households, as compared with the heads of the white immobile households in 1939, it appears evident that both had advanced more rapidly in the preceding ten years.

The generally more depressed tenure levels characterizing the three Negro residential categories make comparison with the whites difficult. (See Table XII.) However, it is apparent that whatever increase of ownership was experienced by the heads of the households of the two migrant groups in the ten years, it was a net increase. In 1929 not a single representative of either of these groups was classed as an owner. In contrast, slightly over one-tenth of the heads of the immobile households began the study interval as owners, and by 1939 this proportion had approximately doubled. The cropper class of the three residential categories decreased in number substantially during the decade. It appears that the major proportion of the heads of the immobile households leaving the cropper status were diverted upward toward the owner level, while the heads of the migrant households leaving this same status were more often shunted down into the laborer class. Therefore, the laborer class of the migrant groups assumed relatively more significance by 1939, whereas the small increase of this lowest tenure class among the heads of the immobile Negro households was inconsequential.

The virtually exclusive role of promoting tenure advancement for the heads of the white and Negro households, particularly to the ownership level, was played by the new ground family-size farm units. Furthermore, the evidence conclusively indicates that the new ground settlement, as it has progressed thus far, has had the effect of increasing the disparity between the proportions of owners included among the whites and the Negroes of the sample area. At the same time, however, this settlement has significantly raised the average tenure level in the area.

Levels of Living

Some insight into the success of the entering migrants in equalling or surpassing the level of living of the sedentary persons in the survey area is afforded by a comparison of housing and of selected material items comprising the three residential categories. Moreover, in order to get at the relative nonmaterial level of living of the migrants, the proportions of the households of the three residential categories possessing certain items not ordinarily considered elements of material living are analyzed. Implicit in this approach, then, are the two basic assumptions, first, that the total or composite level of living includes nonmaterial elements, and, second, that certain tangible possessions are nonmaterial living experienced by a household.

The farm population of the entire Mississippi delta area, as a group, lives at an extremely low material level.[46] Mangus stated that in this area, "The rural-farm plane of living is lower than in any other major region. Only the favored few have houses whose value approaches the United States average, and the possession of such conveniences as telephones, running water, electric lights, automobiles, and radios is very limited."[47]

Since the level of living of the great majority of the farmers is thus depressed and channelized at the base of the socio-economic pyramid, differentials between the migrant and non-migrant households are certain to be small and difficult of perception. However, from a study of Negro sharecroppers and wage laborers in other sections of the delta area, Olen E. Leonard and Charles P. Loomis concluded that, "in terms of estimated total [living] values, it is plainly evident that high mobility is associated with lower levels of living."[48] In the main, the same conclusion seems to be indicated by the findings of this study both with reference to housing and to the possession of selected household items.

Housing, along with food and clothing, is generally accepted as a basic element of healthful living. Perhaps the most common, as well as the most important, deficiency in rural housing is lack of space. Since the migrant families were significantly larger than the immobile families, the relative extent of crowding is revealed more accurately by a comparison of the number of rooms per person than per household. (See Table XIII.) Irrespective of race and type of farm, the persons of the immobile category had more room than the persons of either of the two migrant groups. Although, on the whole, the persons of the two migrant groups had about the same average amount of space, there was one significant difference. The white migrants to family-size farms from non-delta territory had only .53 rooms per person as compared with the .72 rooms of the migrants from within the delta area. The larger size of the families from non-delta territory was partially responsible for this smaller room-person ratio.

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[46] Carl C. Taylor, Helen W. Wheeler, and E. L. Kirkpatrick, *Disadvantaged Classes in American Agriculture,* Social Research Report No. 8, U. S. Department of Agriculture, April, 1938; and Max R. White, Douglas Ensminger, and Cecil L. Gregory, *Rich Land-Poor People.*

[47] A. R. Mangus, *op. cit.,* p. 22.

[48] "A Study of Mobility and Levels of Living Among Negro Sharecropper and Wage-Laborer Families of the Arkansas River Valleys," *Farm Population and Rural Life Activities,* Washington, D. C., April 15, 1939, p. 3.

The Negro persons, in the main, had more room than the white persons. This greater space per person is a result of the relatively smaller-sized Negro families. Whereas the space per person varied little for Negroes between the family-size farm and the plantation dwellings, the latter provided the whites significantly more room. The low room-person ratio on the white family-size farm indicates the inadequate housing on the new ground farms. The Negro family-size farm dwellings, on the other hand, were predominantly on the old long-cultivated land, and, though less recently constructed than the new ground buildings, were superior for the most part.

Of all race, residence, and type-of-farm groups, the highest room-person ratio was exhibited by the immobile white plantation residents, who had

TABLE XIII. THE AVERAGE NUMBER OF ROOMS PER PERSON IN PRESENT DWELLINGS (1939) IN EACH OF THE THREE RESIDENTIAL CATEGORIES, CLASSIFIED BY TYPE OF FARM AND RACE

RACE AND TYPE OF OPERATING UNIT	Total	Within ward	Within delta	Into delta
Total				
TOTAL	.82	.92	.79	.71
White	.77	.98	.79	.68
Negro	.86	.90	.81	.83
Family-size farm				
TOTAL	.70	.85	.73	.54
White	.64	.77	.72	.53
Negro	.86	.89	.75	.72
Plantation				
TOTAL	.89	.95	.83	.87
White	.95	1.25	.87	.89
Negro	.87	.91	.81	.84

an average of 1.25 rooms per person. This high room-person ratio is partially the result of the smaller size of the white immobile households. Also, the inclusion of a few plantation owners perhaps raises somewhat the average room-person ratio for the total group. Interestingly, of all the persons in the sample, only those of this particular race and residence group have adequate housing on the basis of the generally accepted minimum standard of one room to a person.

The superior material level of living of the non-migrants as compared with the migrants is also suggested by the more frequent possession of certain material goods or items. Since such usual level of living items as electricity, running water, modern baths, and telephones are only rarely present in the area, they are of no value in differentiating the typical level of living of the migrants from that of the non-migrants. Significant residential differences, however, were apparent for other items. (See Table XIV.)

TABLE XIV. THE PERCENTAGE OF WHITE AND NEGRO HOUSEHOLDS IN EACH OF THE THREE RESIDENTIAL CATEGORIES POSSESSING SELECTED MATERIAL AND NONMATERIAL LEVEL OF LIVING ITEMS.

LEVEL OF LIVING ITEMS	Total	Within ward	Within delta	Into delta
Material Items				
White				
Automobile	33.7	45.7	22.2	38.2
Radio	34.6	36.2	34.1	34.3
Ice box	26.5	29.8	25.3	26.1
Sewing Machine	53.0	53.2	54.9	51.4
Daily paper	28.1	31.9	23.1	30.6
Weekly paper	18.5	40.4	9.9	6.2
Negro				
Automobile	6.6	6.5	5.8	8.9
Radio	10.0	11.4	8.3	6.7
Ice box	16.6	17.6	17.5	9.9
Sewing machine	44.9	50.6	37.5	33.3
Daily paper	2.2	2.0	2.5	2.2
Weekly paper	7.6	9.8	5.0	2.2
Nonmaterial Items				
White				
Bible	83.2	85.1	82.4	84.5
Family album	32.9	38.3	28.6	34.2
Musical instrument	32.9	38.3	26.4	36.0
Flowers	62.7	68.1	57.1	64.9
Hunting dogs	45.8	57.4	42.9	43.2
Negro				
Bible	68.8	75.1	63.3	48.9
Family album	9.8	10.6	8.3	8.9
Musical instrument	16.1	17.9	12.5	15.5
Flowers	63.7	63.3	64.2	64.4
Hunting dogs	35.6	40.0	30.0	26.7

For the white sample, automobiles and ice boxes were more frequently owned by the immobile than by the migrant households. Also the former more often subscribed to a daily and weekly paper. However, radios and sewing machines were owned by approximately the same proportions of the three residential groups. Negro migrant, compared with sedentary households, appeared less at a disadvantage. Nevertheless, fewer of them were taking a weekly paper and fewer of them owned a radio or a sewing machine. But, on the whole, the difference between the Negro nonmigrants and migrants appeared less marked than was the case for the whites. Perhaps a level of living as depressed as that of the Negroes is less sensitive to the shocks of changes of residence and is therefore less subject to variation.

The households of three residential categories were also compared with respect to the possession of a group of items thought to bear a closer relationship to the nonmaterial than the material level of living. Included among these were the following items: Bible, family album, musical instrument, flowers, and hunting dog. (See Table XIV.) Whatever these items may indicate, they were included among the possessions of the immobile households significantly more often than among the households of either migrant group. This residential pattern with respect to most of the items prevailed for both racial groups. However, among the white households there was little difference in the proportions keeping a Bible and among the Negro households in the proportions raising flowers. These exceptions notwithstanding, the more frequent inclusion of these items among the possessions of the immobile households irrespective of race was apparent. Although consistent differences were not exhibited by the two Negro migrant groups, there was some evidence among the whites that larger proportions of the households from non-delta territory than from within the delta area possessed the items.

PART IV

GENERAL CONCLUSIONS AND IMPLICATIONS

1. The intensive analysis of the magnitude of movements into and out of a single delta ward during the past decade indicated that while the "new ground" gained rapidly in population, the plantation section sustained a substantial loss. For the total delta area this may have the following implications: (a) The amount of new ground settlement occurring in the delta parishes since 1930 may have a distinct bearing on whether the total farm population of each showed an increase or a decrease through migration between 1930 and 1940. (b) Small net changes in total numbers in some parishes may obscure marked spatial redistribution of the farm population.

2. Significant proportions of the white population of the delta have infiltrated from the surrounding upland hill areas. Almost one-half of the white households residing in the sample ward in 1939 reported having entered the delta area during the preceding 10 years. Analysis of place-of-birth data showed that the heads of the white households were not only foreign to the delta area but that a great majority of them were born in the neighboring upland sections of Louisiana, Arkansas, and Mississippi. This means that insofar as the transfer from a hill to a delta area compels a radical revision of the accustomed way of life, the problems of readjustment are almost exclusively confined to whites, although Negroes are in a decided majority in the area.

3. The resident farm population of no other major region is, perhaps, characterized by such a high rate of inter-farm mobility. Five-sixths of the sample households occupied their 1939 farms after 1928; two-thirds of the sample households occupied their present farms after 1934. It seems that the agricultural population of the delta area has developed a tradition of residential instability. Although on the whole these moves between farms are for short distances, a considerable share of them may be socially significant in that they necessitate the breaking of social bonds and the making of new ones.

4. The two races do not contribute equally to the high rate of farm-to-farm movement prevailing in the delta. Negro households move less frequently and shorter distances than the white households. White families more often moved into the delta from distant and diverse areas and they more often shifted about between farms in the delta. The social and economic wastage entailed by the excessive movement is therefore more largely a loss to the whites. Moreover, any policy designed to lessen un-

necessary and uneconomic movement must be directed particularly toward the more migratory white segment of the population.

5. The most significant socio-economic development occurring in the delta during the past decade has been the rapid settlement of farm households on small, supposedly family-size parcels of cut-over land, or of "new ground" as it is popularly termed in the area. A large majority of the settling households are white and most of them move to the new ground from nearby plantations of the delta. In the sample area there was only one Negro household for every four white households among the settlers, a ratio which appears to prevail throughout the upper delta of Louisiana. The predominance of white settlers has already materially affected the racial balance in the delta, and if, in the future, this settlement continues as predicted and the same ratio of whites to Negroes maintains, the proportion of the total population constituted by whites will experience a significant increase. Institutional repercussions doubtlessly have already been felt as a result of the racial shift now in progress. Educational, religious, and political readjustments are inevitable. The increase of potential voters outside the traditional plantation structure has extreme political significance.

6. Although the reason most frequently given by the migrant households as the primary cause for each move was the desire for a more profitable setup, it was evident that social and psychological considerations frequently make the migration process an irrational, subjective matter. The important influence of non-economic factors on migration was clearly suggested by the fact that within 10 years a relatively large number of heads of white households moved from a small area in Arkansas over 200 miles away to a distinctly different socio-economic area and settled within a limited geographical unit, the sample ward. This testimonial of the importance of social considerations on population movements should indicate to the policy-maker that any purely economic attempt to control migration is foredoomed to failure.

7. Residential stability has not been achieved by the settlers on the new ground. Nearly half of the new ground farms had been occupied for varying periods by one or more other families before being taken by the 1939 residents. One-third of the farms previously occupied remained vacant for more than six months awaiting present occupants. Not only then had some families failed to make a go on many of the farms but other families were hesitant to make the attempt. The rate of farm turnover was distinctly higher for the whites than for the Negroes on the new ground as well as for the sample as a whole. These considerations make it apparent that if small family-size farms are the answer to the agricultural problems of the area, as some have suggested, these units must differ in numerous and important respects from the new ground farms that have been conceived, sold, and settled independent of a rationally determined public policy.

8. Migrants differed significantly in many respects from the sedentees. The former were more often included in the age classes under 15 and 15-45, but they were under-represented in the group 45 and over. In accord with these age differences is the fact that families comprised of husband, wife, and children were relatively more numerous among the migrants than among the non-migrants. Also, the migrant households, in the main, were larger than the non-migrant households. A net in-migration of those families means, in addition to the net numerical change of population, proportionately more workers of the productive ages. However, from the standpoint of dependency, the concomitant increase of dependent children somewhat counterbalances the salient effect of the scarcity of aged dependents. The children represent additional burdens for the school resources of the area. And the young adults, if they remain in the area, will serve as a source of more children in the near future.

9. As is generally the case for rural areas, each advance in tenure status in the direction of ownership tended to exert a stabilizing influence on residence. Proportionately, among both whites and Negroes, more of the years spent in agriculture since 1930 by the heads of migrant households had been at the cropper and laborer levels and fewer of the years at the owner level than was the case for the heads of immobile households. Moreover, the heads of the two groups of migrant households, on the whole, had not climbed to a tenure level equal to that of the heads of the resident households by 1939. However, in spite of the relatively inferior tenure ranking of the two migrant groups as compared with the immobile group in 1939, it appeared that both had advanced more rapidly in the preceding ten years.

10. Although the level of living of the great majority of the farm families in the delta is depressed and channelized at the base of the socio-economic pyramid, evidence clearly indicates that the migrant households had not achieved by 1939 a level of living equal to that of the settled households. In respect to housing, the persons of the immobile category of both races had more room than the persons of either of the two migrant groups, regardless of race. The superior level of living of the residents as compared with the migrants is also demonstrated by their more frequent possession of selected material goods as well as certain items thought to bear a closer relationship to nonmaterial living. The more inadequate level of living of the migrant reflects the tremendous social and economic wastage incurred by frequent aimless moves, most of which represent the exchange of equally unfortunate situations.

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BIOLOGY AND CONTROL OF THE TURNIP APHID

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BIOLOGY AND CONTROL OF THE TURNIP APHID

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INTRODUCTION

The turnip aphid (*Rhopalosiphum pseudobrassicae* (Davis))[2] is the major insect pest of turnips, mustard, and radishes in the South. These crops are not only of great commercial importance throughout the regions of the South where winter vegetables are produced, but they constitute an important source of fresh vegetables for the families of approximately 90 percent of the home gardeners in this section of the country, particularly in localities where the leafy portions of turnips and mustard are used as "greens" or "salad."

The turnip aphid was first recognized as a pest in 1914, and nicotine as a dust or a spray has been used largely in attempts to control it. Since results obtained with this material have varied widely in different localities and even in the same locality under different conditions, the Bureau of Entomology and Plant Quarantine began a study of the biology and control of the insect in 1932 in an effort to develop more satisfactory control measures. The investigation was carried on at Baton Rouge, La., and the results of the experiments with insecticides were briefly summarized by D. J. Caffery,[3] assistant to the Division leader, as follows:

> Dust mixtures containing derris or cube proved effective in protecting turnip and mustard from injury by the turnip aphid, a widely distributed pest on leafy vegetables, and not only solved the problem of avoiding harmful residues on affected crops, but served as the initial step, which was followed by many investigators, in the successful use of insecticides containing rotenone against several species of aphids which had heretofore baffled efforts to control them with insecticides.

The data obtained on biology in this investigation are basic to, and are of value in, the consideration of the control of the turnip aphid by crop management and by the use of insecticides. The biological data and the results of experiments with insecticides are given in this bulletin.

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[1] The writers are indebted to C. E. Smith, under whose supervision this work was done, for valuable counsel and criticisms; to M. C. Edenfield, W. T. Robinson, and Marshall R. Smith for assistance in the laboratory and field; to Janet Mabry, of the Division of Insect Pest Survey and Information, for assembling the distributional data; and to Ross W. Brubaker, of the Baton Rouge, La., laboratory, for making the photographs for figure 4, figures 6 to 10 inclusive, and figures 13 and 14.

[2] Order Homoptera, family Aphiidae.

[3] Caffery, D. J. Recent developments in vegetable insecticides. Manuscript report, Division Leader's Meeting, Washington, D. C., November 28-December 3, 1938.

EXTENT OF INJURY

Since the time required by the turnip aphid to complete its development is comparatively short and since all the individuals are females, no males being required for reproduction, the insect is capable of increasing to large numbers within a short time on any given crop when conditions are favorable. Marcovitch (7)[4] estimates that a heavily infested field of turnips may contain as many as 30,000,000 aphids per acre.

The total damage caused by this insect is difficult to estimate, since much of it has been charged to the cabbage aphid (*Brevicoryne brassicae* (L)). Its depredations, however, frequently result in the entire destruction of commercial plantings, involving large monetary loss in instances where competition for early crops is keen, and reaching large aggregate losses in home gardens, where susceptible crops are often injured severely or are entirely destroyed. Hyslop[5] estimates that the annual loss of cole crops in Louisiana, Texas, Mississippi, Alabama, Florida, Georgia, and South Carolina amounts to $2,800,000. Owing to the losses caused by this pest, the growing of turnips and related crops has been abandoned in many localities.

DISTRIBUTION

The distribution of the turnip aphid in the United States according to the records of the Division of Insect Pest Survey and Information, Bureau of Entomology and Plant Quarantine, is presented in figure 1.

Davis and Satterthwait (*4*) state that the turnip aphid is widely distributed in North America, from Manitoba to Texas and from Massachusetts to California. The species has also been reported as occurring in South Africa, Japan, and Argentina.

REVIEW OF LITERATURE

The first record of the turnip aphid as a pest of cultivated crops in the United States was published in 1914, but the insect was not recognized as a new species until Davis (*3*) described it as *Aphis pseudobrassicae* from specimens sent him by W. J. Schoene of Geneva, N. Y., who collected them from cabbage on July 15, 1912. Davis and Satterthwait (*4*) discussed the habits of the aphid and the seriousness of its damage to turnip and other cultivated crops, and gave a description of the immature stages, which was not included in the original description. Paddock (*8, 9*) reported this aphid to be very destructive over the entire State of Texas. Hull (*6*), in 1929, stated that for several years plant lice, chiefly the turnip aphid, had given an unusually large amount of trouble to growers of vegetables along the Gulf coast of Texas and had threatened the extinction of the industry in that section. Hinds (*5*) stated that the turnip aphid was the most common species infesting turnips in the South, and that fall-grown turnips were nearly always infested to a serious extent.

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[4] Italic numbers in parentheses refer to Literature Cited, p. 38.

[5] Hyslop, J. A. losses occasioned by insects, mites, and ticks, in the United States. U. S. Bur. Ent. and Plant Quar. Cir. E-444, 57 pp. 1938. Processed.

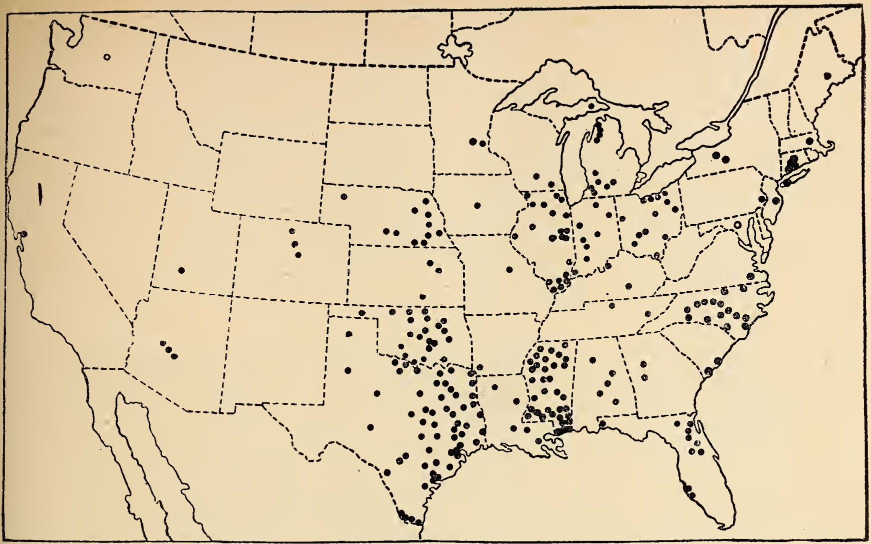

FIGURE 1.—Distribution of the Turnip Aphid in the United States. The Open Circles Indicate That the Aphid Has Been Found Somewhere in the State, But That the Specific Location Is Not Available.

DESCRIPTION OF THE APHID

The original description of the adult forms of the turnip aphid was given by Davis (*3*). The following is a brief description of the wingless and winged viviparous adult females:

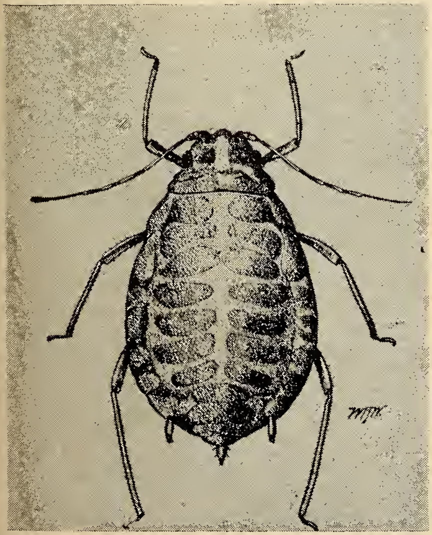

FIGURE 2.—Wingless Female Adult of the Turnip Aphid, About × 25. (Davis)

The wingless viviparous female (Fig. 2) when fully grown is a little over 1/16 inch in length and is slightly longer than wide. The entire body is pale green, and the head is slightly dusky. The antennae are pale green in the basal and middle portions, blackish toward the tips, and of sufficient length to reach a little beyond the middle of the body. The legs are pale green with dusky joints, and the tips of the legs are blackish. The body is generally dull in appearance and is covered very lightly with minute powderlike scales, in this respect being markedly different from the cabbage aphid (*Brevicoryne brassicae (L.)*), often confused with the turnip aphid, which is characterized by having a dense covering of these scales on the body. The eyes are black. The cornicles are pale, with the tip dusky, and noticeably longer than the cornicles of the cabbage aphid.

The winged viviparous female (Fig. 3) is slightly less than 1/16 inch in length and is about twice as long as wide. The head and thorax are black. The abdomen is pale apple green with a tint of Nile green. The antennae are black and of sufficient length to reach almost to the bases of the cornicles. The legs are pale brown to black, with black tips. The cornicles are dusky, paler at the tips, with the same length and shape as those of the wingless female. The wings are transparent with black veins. The eyes are black.

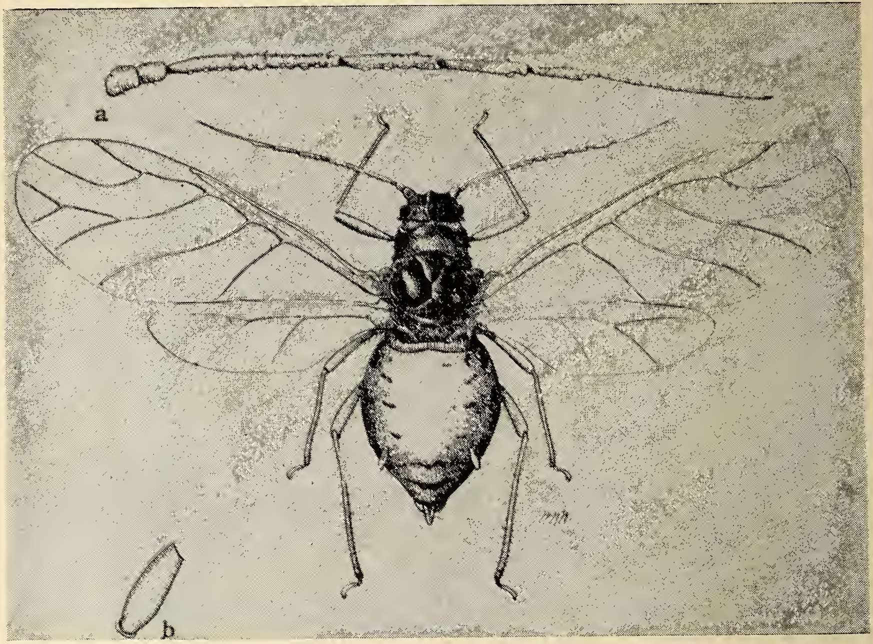

FIGURE 3.—Winged Female Adult of the Turnip Aphid, About × 25: *a,* Antenna; *b,* Cornicle; *a,* and *b* Greatly Enlarged. (Davis.)

On December 23, 1932, L. B. Reed collected from mustard at Chadbourn, N. C., specimens of wingless and oviparous female aphids which were identified by P. W. Mason as *Rhopalosiphum pseudobrassicae.*[6] These individuals were associated with wingless and winged viviparous females of the same species.

FOOD HABITS AND CHARACTER OF INJURY

The turnip aphid prefers young plants or the new growth of older plants on which to feed. The young aphids begin feeding on the surrounding plant tissues soon after they are born and may grow to maturity without moving to another part of the host. When plants produce seeds the aphids concentrate on the youngest and tenderest growth of the seed stalks.

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[6] From unpublished notes on file in the Bureau of Entomology and Plant Quarantine.

Injury is caused by the insects sucking the plant juices. Usually the first noticeable sign of an infestation is the curling of the leaves. If the plants are heavily infested when very young they may soon be stunted or even killed (Fig. 4). On larger, heavily infested plants, the leaves curl and turn yellow, and the plants may soon die (Fig. 5).

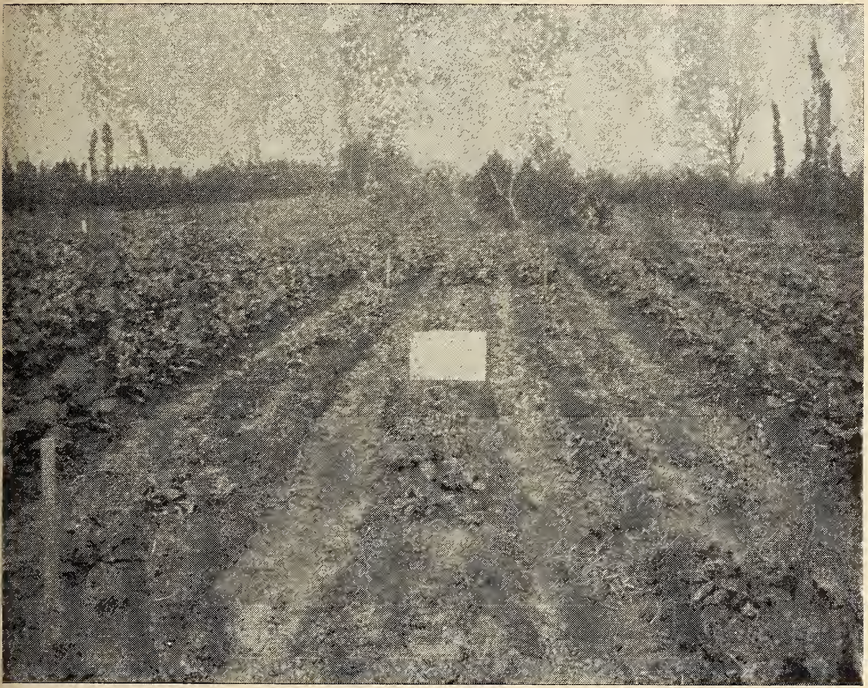

FIGURE 4.—Field of Mustard in Field-Plot Experiment 4, Baton Rouge, La., 1936. The Plants in the Center Foreground Were Untreated and Were Almost All Killed When Small. Other Portions Were Treated for the Aphids.

LIFE-HISTORY STUDIES

The life history of the turnip aphid was worked out in Indiana by Davis and Satterthwait (*4*) and in Texas by Paddock (*8*). In an effort to plan control studies, a more detailed life-history study was begun at Baton Rouge in 1932 and continued for more than 2 consecutive years. The studies were conducted in an outdoor insectary and daily observations were made on individual females confined on turnip or mustard plants growing in ordinary 6-inch earthen flowerpots.

Number of Generations

By using as nearly as possible the first born of the first born of each successive generation, the maximum number of generations produced was determined. Likewise, by using as nearly as possible the last born of the last born of each successive generation, the minimum number of generations was ascertained.

The date of birth of each female for the maximum and minimum records of generations produced from July 3, 1932, to June 27, 1934, is presented in table 1. Very young turnip or mustard plants, which are the preferred food, were not used until April, 1933, and this at least partly accounted for the fact that fewer cases of rapid development were obtained in 1932-33 than in 1933-34. By counting the individual with which the studies were begun, 46 generations were obtained from January 5, 1933, to December 22, 1933, and likewise from July 3, 1933, to June 27, 1934. This, incidentally, is a rapid rate of reproduction.

TABLE 1.—DATE OF BIRTH OF THE FIRST BORN OF THE FIRST BORN AND THE LAST BORN OF THE LAST BORN OF FEMALES OF SUCCESSIVE GENERATIONS OF THE TURNIP APHID REARED IN THE INSECTARY AT BATON ROUGE, LA.

YEAR AND MONTH	DAY OF THE MONTH OF SUCCESSIVE BIRTHS OF—	
	First born of first born	Last born of last born
1932—July	3, 7, 16, 23	4, 21
August	7, 14, 22, 28	2, 14. 25
September	3, 9, 15, 21, 27	10, 29
October	5, 18, 28	26
November	10, 29	15
December	19	19
1933—January	5, 20	10
February	1, 19	10
March	3, 16, 27	17
April	4, 12, 23, 28	13
May	4, 9, 16, 21, 27	17
June	2, 8, 14, 21	8, 26
July	3, 8, 13, 19, 24, 30	8, 24
August	4, 10, 15, 22, 28	7, 18
September	3, 9, 15, 21, 27	8, 25
October	2, 10, 18, 25	17
November	3, 13, 22	15
December	3, 13, 22	25
1934—January	2, 18	..
February	2, 20	8
March	8, 23	10
April	3, 9, 18, 26	8
May	4, 10, 16, 24, 30	5, 25
June	5, 11, 16, 21, 27	20

A general study of the life history included the growth or developmental period, number of young per female, reproduction period, length of adult life, production of winged females, and the effects of the host plant, seasonal changes, and temperature on the species. A summary of the more important data obtained in these studies is presented by months in table 2.

TABLE 2.—AVERAGE LIFE DATA FOR FEMALES OF THE TURNIP APHID BORN IN VARIOUS MONTHS FROM JULY, 1932, THROUGH JUNE, 1934.

REARED ON TRANSPLANTED PLANTS, 1932-33

MONTH OF BIRTH	Females used	Average age at beginning of reproduction	Young per female	Average reproduction period	Average length of adult life	Temperature for life period averaged every 2 hours
	Number	*Days*	*Number*	*Days*	*Days*	*°F.*
July	21	6.7	19.5	6.8	13.1	80.8
August	23	6.0	36.5	8.5	14.8	78.7
September	35	6.8	43.2	10.4	17.9	72.7
October	19	10.4	36.7	16.0	30.6	58.0
November	11	13.0	54.1	25.4	40.5	52.8
December	3	16.3	43.0	18.7	42.3	54.7
January	12	13.0	46.5	16.0	30.8	56.2
February	7	15.4	74.0	16.7	44.6	58.4
March	13	10.2	71.4	18.6	39.0	63.5
April	11	7.2	54.7	12.2	21.9	69.5
REARED ON VERY YOUNG PLANTS, 1933-34						
May	18	6.2	69.2	13.8	23.7	74.9
June	21	6.1	58.9	9.5	17.4	76.1
July	29	5.7	49.8	9.6	16.38	76.95
August	25	5.9	59.6	12.6	18.72	77.34
September	30	5.8	67.1	14.5	22.56	74.24
October	25	7.6	89.4	21.0	38.00	61.97
November	10	11.8	90.4	18.1	43.91	58.74
December	15	11.8	89.0	23.3	43.00	55.34
January	8	17.3	59.8	17.8	43.87	53.42
February	6	16.3	56.7	19.8	45.16	57.15
March	6	12.3	92.3	18.0	42.00	63.05
April	9	8.6	55.4	12.0	23.33	69.31
May	12	6.4	86.3	14.5	24.41	74.48
June	10	5.2	82.2	10.6	16.80	79.52

STUDY OF LIFE HISTORY IN GENERAL

When desirable food was supplied, the rate of growth was closely associated with the temperature, the faster growth being associated with higher temperatures and slower growth with the lower temperatures. The time elapsing from birth to beginning of reproduction was found to range from 4 days in the summer to 21 days in the winter, and the maximum reproduction period for all records was 43 days. There was a significant negative linear relationship between the length of adult life and the average temperature as reported by Allen (*2*). The observed length of adult life ranged from 7 to 66 days.

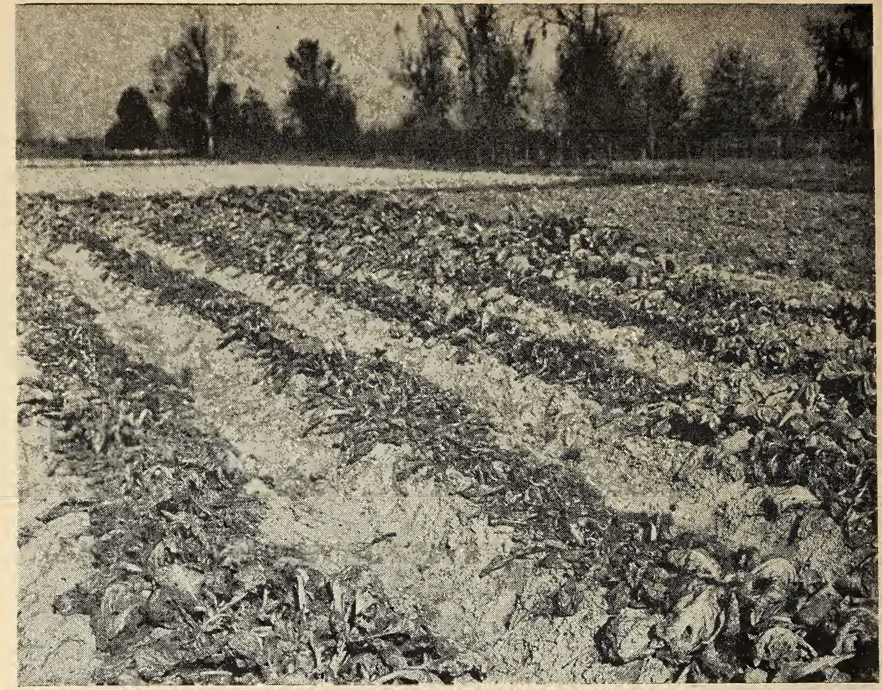

FIGURE 5.—A Field of Mustard Nearly Ready to Harvest, Severely Injured by the Turnip Aphid.

When transplanted turnip plants were provided for food, the females produced many more young during the cooler months than during the warmer months. Reproduction by females supplied with young plants grown from seed was more nearly normal during the summer months, although the maximum number of births and the highest averages, in general, were obtained during the cooler months. The number of offspring per female ranged from none to 123.

Winged Females

Careful observations in connection with the life-history studies and with the molting experiments strongly indicated that the production of winged individuals was closely associated with a deficiency in the quantity of food material in the plant or the inability of the individuals to obtain sufficient food for optimum growth because of the reduced succulency of the plant. The largest number of winged individuals were produced on stunted, weakened, or more mature plants, regardless of the number of individuals on the plant. Winged aphids were seldom produced on young, tender, succulent plants except during May and September, when it appeared that some physioloigcal factor in the aphids contributed to the increased percentage of winged individuals.

According to P. W. Mason[7] the larger number of alates produced in May and September is undoubtedly a reversion. This species, like other aphids, originally migrated between primary and secondary hosts. For some reason the primary host is not now used. Perhaps it has become extinct. The aphid is continuing to live on the secondary host, but has not completely lost its original tendency to produce migrating forms in the spring and fall.

Discussion of Life-History Data

When the life-history studies were first begun, brass-screen cages were constructed and these were compared with common lantern globes, topped with cheesecloth. Since better results were obtained with the lantern globes than with the cages, the globes were used in later studies.

The turnip plants that had been transplanted to flowerpots made poor growth during the hot months, and feamles repeatedly crawled off the plants and were found near the top and on the sides of the containers. As early as April 1932 it became evident that the aphids confined on these plants were not being supplied the best food, for they grew more slowly, produced fewer young, reproduced over a shorter period, and lived fewer days, in general, than those observed during February and March of 1932 or those fed better food in later experiments.

Field infestations were observed on mustard in August 1932, and for this reason mustard plants were transplanted to pots and used in the life-history studies. As the aphids appeared to thrive on them, a comparison was made between mustard and turnips as host plants. Records were obtained from 38 females on mustard under screen and 19 under lantern globes, and from 70 females on turnips under screen, and 12 under lantern globes. At the end of December the records were assembled and classified by months. If the number of young produced is selected as a criterion, mustard was a much better host plant during August and September; but if the length of adult life is the deciding factor, there were no significant differences between the results on the two host plants for any month.

After April 1933, seeds were planted in flowerpots to produce very young turnip or mustard plants for the life-history studies. The young plants appeared to supply optimum food requirements for the aphids.

Molting

In studying the molting of the aphids, individual nymphs were placed on young plants growing in flowerpots. A circular piece of black paper placed around the base of each plant upon which a nymph was confined facilitated location of the molted skins. A lantern globe was placed over each individual plant and nymph and examinations made twice daily. Four molts appear to be the normal number, although some nymphs molted only three times while a few molted five times. During the sum-

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[7] In personal correspondence.

TABLE 3.—A Summary of the Molting Observations on the Turnip Aphid Reared in the Insectary at Baton Rouge, La., 1934.

Date of birth	Nymphs used	Duration of—				Average time from last molt to beginning of reproduction	Age at beginning of reproduction	Average temperature for life span*
		First stadium	Second stadium	Third stadium	Fourth stadium			
	Number	*Days*	*Days*	*Days*	*Days*	*Days*	*Days*	°*F*
Aug. 6	7	1.6	1.1	1.0	1.1	1.0	5.9	81.4
13	12	1.4	1.1	1.0	1.1	1.0	5.6	80.4
20	12	1.2	1.0	1.0	1.3	1.0	5.6	80.1
27	10	1.6	1.1	1.0	1.4	1.0	6.2	77.4
Sept. 11	12	1.7	1.0	1.0	2.0	1.0	6.7	78.1
19	13	1.7	1.0	1.2	1.5	1.0	6.4	77.6

*Averaged for 2-hour periods.

mer females were frequently observed to begin reproducing in less than 8 hours after the last molt.

Table 3 gives the records of those nymphs that molted four times. The averages for the length of time spent in each stadium are somewhat biased because they are based on two observations daily, and give a figure that is nearer the maximum than the minimum average time. Of the 12 nymphs born on September 11, 7 were winged when mature, and the increase in length of developmental period was due largely to the additional time required in the fourth stadium for the winged individuals to develop. Nymphs born September 19 were reared on plants similar to those used for nymphs born September 11 and in the same insectary.

Relationship of Temperature and Season to the Life History of the Turnip Aphid

The life-history studies during the summer and fall of 1932 were adversely affected by undesirable food conditions during the hot months because transplanted plants were used. As it was desired to determine if possible to what extent temperature was a factor in the results obtained, very young plants exclusively were used for the studies during 1933-34, to eliminate as far as possible the condition of the host as a factor. The data were assembled separately for 1932-33 and 1933-34.

Temperature readings for each 2 hours of every female's life period were obtained from a hygrothermograph that was kept in a standard Weather Bureau instrument shelter approximately 100 yards from the insectary. The average temperature for the period spent by every female in each of its life stadia was recorded, and the results were assembled by temperature.

Scatter diagrams were made by plotting the average length of adult life, the number of young produced, and the reproduction period against the prevailing temperature. The relationship of temperature to the length of adult life was found to more nearly approximate a straight line; and the coefficient of correlation of this relationship for the 1932-33 data was—.7792, and for 1933-34, was—.4849.

The relationship of temperature to the length of adult life of the female turnip aphid therefore appeared more pronounced in 1932-33 than in 1933-34. It is evident that the use of transplanted turnip plants which made poor growth during the hot months was a major factor in the results obtained during that season. With very young plants used exclusively in 1933-34, the relationship of temperature to the length of adult life was not so pronounced, indicating that some factor other than temperature affected the aphids.

The same data were reassembled so that all females that were born in any single month were grouped together and the mean temperatures for the life period averaged for a monthly temperature. The relationship of temperature to the length of adult life was again studied. The correlation coefficient for the 1932-33 data was—.90 and that for the 1933-34, —.97. These data have been presented in table 2.

The data for the 2-year life-history study show that the length of adult life of the female turnip aphid is markedly influenced by temperature. It would appear, however, that there is a definite seasonal influence on its life and activity. An index-number chart such as suggested by Allen (2), prepared from the data obtained in 1933-34, when only very young plants were used for food, showed that the line representing the temperature crossed the lines representing the different life-history phases studied at the time in the spring and fall when winged individuals are produced. The winged individuals in the fall initiate the infestation on field plants, whereas the winged individuals in the spring move away from the field plants.

SEASONAL HISTORY

The seasonal activity of the turnip aphid is influenced by the availability of desirable food and by climatic factors. Although the aphid is present in Louisiana throughout the year, it thrives best and causes most damage during the cool seasons. Life-history studies, confirmed by field observations, showed that winged individuals are produced in greater numbers during September and May than in any other months, regardless of the age and thriftiness of the host plants. These peaks are coincident with the beginning and ending of the period of optimum growing conditions of turnips, mustard, radishes, and other favored cultivated host plants. With the dispersal of the winged aphids about the middle of April, accompanied by an increased activity of natural control agents, the species is usually reduced to non-injurious numbers.

As there was no positive information as to the whereabouts of the species in the South during the summer, considerable time was devoted to searching for alternate wild host plants on which it might survive. While the aphid infests a number of wild plants, especially during the winter and spring, none were found that could be considered suitable and responsible for carrying the species through the summer period.

Although it is practically impossible to grow turnips successfully in the South during the summer, a few plants may be found in Louisiana at this time growing either from planted seed or as volunteers in low, damp places. Where rainfall is sufficient, some varieties of mustard are grown during the summer months and serve as hosts. Collards, grown extensively in home gardens, also aid in carrying the species through this period.

FOOD PLANTS

The turnip aphid shows its greatest affinity for plants belonging to the genus *Brassica,* but does not always confine its attacks to this group. This species has been reported or observed to attack the following plants: Black mustard (*Brassica nigra* Koch), Broccoli (*Brassica oleracea* var.

italica Plench.), Cabbage (*Brassica oleracea* L.), Cauliflower (*Brassica oleracea* var. *botrytis* L.), Chard (*Beta vulgaris* var. *cicla* L.), Collard (*Brassica oleracea* var. *acephala* D. C.), Kale (*Brassica oleracea acephala* D. C.), Kohlrabi (*Brassica caulorapa* Pasq.), Marshcress (*Radicula* sp.), Mustard (*Brassica* sp.), Peppergrass (*Lepidium virginicum* L.), Radish (*Raphanus sativus* L.), Rape (*Brassica napus* L.), Rockcress (*Arabis virginica* (L.) Trelease), Rutabaga (*Brassica napobrassica* Mill.), Savoy cabbage (*Brassica oleracea* var. *capitata* L.), Shepherds-purse (*Bursa bursa-pastoris* (L.) Britton), Ten-week stock (*Mathiola incana* var. *annua* Voss.), Turnip (*Brassica rapa* L.), Wild mustard (*Brassica* sp.) and Wild radish (*Raphanus raphanistrum* L.).

OTHER SPECIES MISTAKEN FOR THE TURNIP APHID

Two species of aphids which are often associated with and may be mistaken for the turnip aphid are the cabbage aphid (*Brevicoryne brassicae* (L.)) and the green peach aphid (*Myzus persicae* (Sulz)). According to Davis and Satterthwait (*4*) the turnip aphid is easily distinguished from the cabbage aphid by its lighter pulverulence, the shining reticulated areas on the dorsum of the wingless forms, the longer cornicles, and the presence of sensoria on antennal segment IV of the winged viviparous female. The cabbage aphid is covered with a whitish, mealy coat of wax grains which are not present on the turnip aphid. The green peach aphid is distinguishable from the turnip aphid by its lighter pale-green color and elongated body.

NATURAL ENEMIES

The turnip aphid has a number of natural enemies, including both internal parasitic and predatory insects, fungus diseases, and birds. Among the insect species, Davis and Satterthwait (*4*) reported *Diaeretus rapae* (Curt.), *Pachyneuron micans* Howard, *Aphidoletes* sp., and the larvae of a syrphid fly. They state: ". . . The common aphid fungus, supposedly *Empusa aphidis,* is also an important check on the turnip plant louse in late fall." Paddock (*8, 9*) reported *Lysiphlebus testaceipes* (Cress.); the ladybird beetles *Coleomegilla maculata* Deg., *Hippodamia convergens* (Guer.), and *Cycloneda munda* (Say); the syrphid flies *Syrphus americanus* Wied. and *Allograpta obliqua* (Say); and lacewing flies. Other natural enemies that have been observed in Louisiana include the ladybird beetle *Cycloneda sanguinea* (L.) and two birds,[8] the eastern Savannah sparrow (*Passerculus sandwichensis savannah* (Wilson)) and the American pipit (*Anthus spinoletta rubescens* (Tunstall)).

CHEMICAL CONTROL

Although natural enemies are valuable aides in controlling this pest, it is necessary, especially during the period when the aphid is most abundant, to apply artificial control remedies to produce turnips, radishes, and mustard successfully. Studies of insecticidal control consisted of laboratory toxicity tests, small-plot field experiments, and a comparison of the two best dust mixtures on a field basis.

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[8] Determined by Geo. H. Lowery, Jr., Assistant Curator, Zoology Museum, Louisiana State University.

Laboratory Toxicity Tests

The laboratory toxicity tests were begun in the fall of 1932 and conducted in an outdoor insectary enclosed on three sides with wire screen, except for a panel of glass 16 inches wide horizontally midway, and on the fourth side by a wooden wall. The sprays were applied with a small atomizer and the dusts with a small plunger-type duster. Aphids from natural field populations were used, one or more infested leaves being used per replicate for each material. The leaves were placed in small bottles of water, and the spaces around the stems were closed with cotton plugs to prevent the aphids from falling into the water. The applications were made by wetting the insects thoroughly with the sprays or covering them with particles of the dusts. Excesses of the materials were shaken off. The bottles containing the treated leaves were then placed in the centers of metal trays about 15 inches in diameter, the rims of which were coated with an adhesive material. An untreated check was used in each series. Observations were made 24 hours after each application, and the percent control was calculated by the method described by Abbott (*1*).

The more important materials used, the number of tests made, the number of aphids used, and the weighted averages of the percentages of control are given in table 4.

The first experiments consisted of spray tests of various strengths of pine-tar and sodium oleate soaps, alone and in combinations with different strengths of nicotine sulfate. In these tests more than 325,000 aphids were used, and it was found that with the humidity near 100 percent and the temperature at 50° F., or less, pine-tar soap was very toxic. The stronger the concentration, at least in the neighborhood of 0.5 percent of dry soap, the better the control.

In 17 tests with pine-tar soap at the strength of 1 pound to 20 gallons of water, involving more than 13,000 aphids, it was found that there was a significant positive correlation between the percent control and the mean relative humidity. With high relative humidity and low temperature prevailing, pine-tar soap at this strength resulted in more than 90 percent control, but when low humidity and high temperature prevailed, it was necessary to add 1 part of nicotine sulfate per 1,000 parts by volume of the soap solution in order to obtain a comparable control.

Nicotine dusts were tested in dilutions ranging from 1 to 4.5 percent incorporated in various materials and combinations of materials as carriers. The mixture containing 3 percent of nicotine in hydrated or builder's lime proved to be the most satisfactory one tested. It was about as toxic as the stronger mixtures and was superior in physical qualities.

TABLE 4.—THE EFFECT OF DIFFERENT SOLUTIONS OF SOAP AND NICOTINE SULFATE ON THE TURNIP APHID IN LABORATORY TESTS

MATERIALS* TESTED	Quantity of water used per pound of soap	Ratio of nicotine sulfate solution to water by volume	Tests	Aphids used	Control
	Gallons		*Number*	*Number*	*Percent*
None (Check)	..	....	37	40,650	0†
Pine-tar soap alone	40	....	7	4,986	39
do	30	....	5	4,404	38
do	25	....	6	4,450	56
do	21	....	3	1,951	63
do	20	....	21	16,103	70
do	19	....	5	5,394	84
do	18	....	7	5,509	71
do	17	....	7	5,143	75
do	16	....	11	7,822	81
do	15	....	9	6,118	82
do	10	....	5	4,352	99
Pine-tar soap and nicotine sulfate	40	1:5000	3	1,864	50
do	30	1:2000	3	3,271	64
do	25	1:2000	8	4,970	83
do	20	1:5000	4	1,979	81
do	20	1:4000	2	1,197	85
do	20	1:3000	9	4,984	84
do	20	1:2500	7	5,719	86
do	20	1:2000	20	14,637	88
do	20	1:1500	5	3,324	96
do	20	1:1000	8	6,164	97
do	20	1: 500	6	5,305	99
do	15	1:10,000	2	2.240	56
Sodium oleate soap alone	20	....	6	4,683	49
do	12	....	3	1,631	51
Sodium oleate soap and nicotine sulfate	20	1:2000	6	4,935	82
do	12	1:5000	3	1,136	84
do	12	1:2000	4	2,893	91

*According to analysis by W. P. Denson, Analytical Chemist, Louisiana Agricultural Experiment Station, the pine-tar soap used contained 6 percent of water by weight and the sodium oleate soap 49.4 percent. The nicotine sulfate was a commercial preparation containing 40 percent of nicotine.

†The natural mortality in the check lots was 10.36 percent, due primarily to parasitized and diseased aphids.

Derris was tested in both spray and dust forms. Although derris sprays, especially the stronger dilutions, gave promising results, the 24-hour period allowed between application and examination appeared too short for the maximum effects to be manifested. For the same reason it was difficult to determine the true toxic value of derris-root dust mixture. One containing 1 percent of rotenone in equal parts of finely ground tobacco dust and 300-mesh dusting sulfur had appeared promising in field tests. After this material was applied to turnip and mustard plants growing in the insectary, vigorous females were placed on the treated plants to determine its residual toxicity. Females placed on plants that had received a light application of the dust deposited young, but the parents and most of the young died later. The adults placed on plants that had received a heavy application of the dust died within the first 24 hours. Some of the females placed on the treated plants after the first 24 hours produced young, but they and the young died in less than 7 days. Apparently, however, derris-root dust mixture was not toxic to the turnip aphid 7 days after it had been applied.

Small-Plot Field Experiments

During the fall of 1933 and spring of 1934 small-plot experiments were conducted on private farms. In these tests nicotine-dust mixtures were compared with various mixtures of ground derris root with one or more of the diluents lime, flour, tobacco dust, and sulfur. Definite conclusions were not deduced from these early tests, but several of the diluents for derris-root powder were eliminated and a derris root dust mixture containing 1 percent of rotenone in equal parts of tobacco dust and sulfur was found to be a promising insecticide.[9]

In the fall of 1934 and during 1935 and 1936 several of the most promising materials and dilutions used in the laboratory toxicity experiments and in the early field tests were tried in replicated small plots under field conditions. Ten experiments were conducted but no significant differences between treatments were demonstrated in several of them, largely because of the low aphid populations. The results of four of the more satisfactory experiments will be presented. One of these was conducted on turnips and three on mustard.

Identical plot arrangements were used for all 4 experiments. Each experiment consisted of 6 replicates of 6 treatments on small plots arranged in a Latin square of 36 plots. In 3 of the experiments the treatments were composed of 5 insecticides and 1 untreated check. In the other experiment all 6 treatments were composed of insecticides. Each plot consisted of 3 rows 3½ feet wide and 34½ feet long. Each row contained 2 drills of plants about 8 inches apart. The plots were separated at their ends by unplanted strips 2 feet wide.

The dusts were mixed in a sifting and mixing machine for a period of 5 minutes not more than 24 hours before the applications were made and kept in tightly closed paper bags. The sprays were mixed immediately previous to their application. The derris dusts containing rotenone were applied either late in the afternoon, early in the evening, or early in the morning, and the nicotine dusts and sprays during the late forenoon or early afternoon while the plants were dry. The materials were applied to the outer side of each drill of plants with rotary hand-operated dusters (Fig. 6) or compressed-air hand sprayers.

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[9] ALLEN, NORMAN. THE TURNIP APHID. U. S. Bureau Ent. and Pl. Quar. Cir. E-324, 3 pp. 1934. (Processed.)

The applications ranged from approximately 15 to 30 pounds of the dusts and from about 100 to 125 gallons of the sprays per acre. A thorough coverage of the plants was sought, especially the undersides of the leaves, which contained a large portion of the aphid population.

The first application was made when the infestation reached an average of about 1 aphid per plant on young plants just up above the soil surface. In cases where infestations were slow in starting, and the plants made some growth before there was an average of 1 aphid per plant, the average number of aphids for certain groups ranged up to 10 per plant, depending on the size of the plants. Subsequent applications were determined by the aphid population, which might have ranged up to an average of 10 per plant, or, in other cases, they were repeated at regular intervals—14 days in most of the tests.

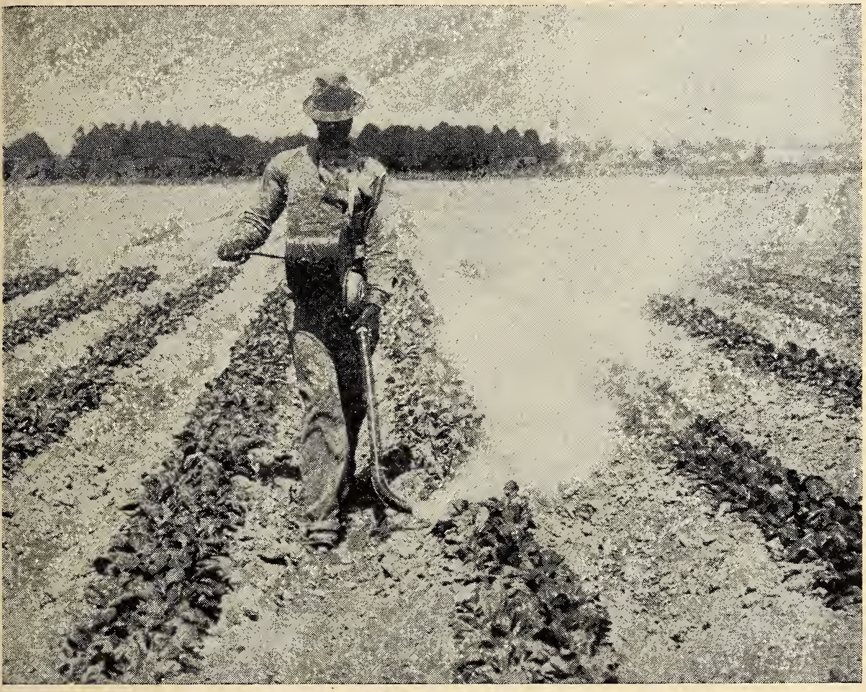

FIGURE 6.—APPLYING DUST MIXTURE FOR THE CONTROL OF THE TURNIP APHID WITH A ROTARY HAND DUSTER. BATON ROUGE, LA., 1938.

Evaluation of the different treatments for experiments 1 and 2 was based on the aphid population and the yield of marketable produce. In experiment 3, where the insecticides were applied at 14-day intervals, and in experiment 4, where the aphid population determined the time of application, only the marketable crop was considered.

Experiment 1

Experiment 1 was conducted on purple top globe turnips during the fall of 1934. The seeds were planted October 6, and the first insecticide application was made October 20. Just prior to the application 50 infested plants on the middle row of each plot were tagged. The aphid population on these plants was counted 5 or 6 days after treatment, all of the tagged plants of the plots composing a complete replicate of all treatments being examined on the same day. The second application was made on November 9, and harvesting was begun on December 12. A summary of the results is given in table 5.

Each insecticidal treatment increased the yield of marketable turnips. The three derris dust mixtures containing 1 percent of rotenone were significantly superior in this respect to the nicotine dust mixtures. The addition of pine oil to the dust mixture did not increase their effectiveness.

The yield of marketable turnips was used for comparative purposes, as it was thought to be a more accurate measure than the total yield. The total yield of turnips may not be a true criterion of protection from plant lice, because where young plants are killed the space between competitive plants may be increased, in consequence of which fewer plants may actually increase the yield.

Experiment 2

Experiment 2 was conducted on Florida broadleafed mustard during the spring of 1936. The seeds were planted March 3, and two applications of the insecticides were made, the first March 24 and the second April 2. The insecticidal treatments were evaluated by aphid survival and yield of marketable mustard, the samples being taken on the middle row of each plot. The aphid population on 25 infested plants was counted just prior to the first application, and again on the same plants 6 days afterward. The mustard of marketable quality produced was harvested April 17 and 20. A summary of the insecticidal applications, aphid survival and yield of mustard is given in table 6.

Although the preapplication population was not evenly distributed over the entire field, the distribution of the plots was such that there were no significant differences between population totals in the different treatments. Six days after the insecticides were applied, however, the populations were found to vary considerably for the different treatments. Actual reductions were obtained only with the derris insecticides.

According to the aphid populations 6 days after the application, there were no significant differences in the effectiveness of the two derris mixtures and 3 percent nicotine dust, but the two derris treatments were more effective than the other three nicotine treatments. There were no significant differences in the number of aphids surviving applications of the

TABLE 5.—COUNTS OF THE APHID POPULATION AND POUNDS OF MARKETABLE TURNIPS OBTAINED FROM PLOTS TREATED WITH EITHER DERRIS POWDER OR NICOTINE DUST MIXTURES IN EXPERIMENT 1, BATON ROUGE, LA., FALL OF 1934.

DESCRIPTION OF INSECTICIDAL MATERIAL			Rate per acre per application	Aphids† on 50 plants	Marketable turnips per plot
Insecticide	Strength	Diluent			
			Pounds	*Number*	*Pounds*
Derris powder	1 percent rotenone	Tobacco dust, sulfur, 1:1	21.9	132	91.3
Derris powder Pine oil	1 percent rotenone 0.5 percent	do	14.4	112	87.9
Derris powder Pine oil	1 percent rotenone 0.25 percent	do	13.8	218	88.3
Nicotine sulfate*	3 percent nicotine	Hydrated lime	18.1	1,198	78.4
Nicotine sulfate* Miscible pine oil	2 percent nicotine 0.5 percent	do	20.6	347	78.8
Check			....	3,237	46.0
Least significant difference for odds of 19:1			....	898	8.4

*40 percent nicotine.

†Counts made 5 or 6 days after the first application.

TABLE 6.—Aphid Population and Pounds of Marketable Mustard Produced on Plots Treated With Either Derris Powder or Nicotine Sulfate Mixtures in Experiment 2, Baton Rouge, La., 1936.

Description of insecticidal material			Rate per acre per application	Aphids† on 50 plants	Marketable mustard per plot
Insecticide	Strength or quantity	Diluent			
			Pounds	*Number*	*Pounds*
Nicotine sulfate*	3 percent nicotine	Hydrated lime	23.6	1,278	17.9
Nicotine sulfate* Ammonium sulfate	2 percent nicotine 5 percent	do	20.0	2,061	16.2
Free nicotine (50 percent)	4 percent nicotine	do	21.3	1,988	16.9
Derris powder	1 percent rotenone	Tobacco dust and sulfer 1-1	36.3	342	23.8
			Gallons		
Derris powder (4 percent rotenone)	2 pounds	50 gallons of water	107.6	415	21.4
Nicotine sulfate* Miscible pine oil Laundry soap	0.5 pint 1 gallon 2 pounds	100 gallons of water	110.2	2,543	16.8
Least significant difference for odds of 19:1			....	1,236	‡

*Containing 40 percent of nicotine.

†Counts made 6 days after first application.

‡The least significant difference was not computed for the reason that the F test showed that the observed differences are not significant.

4-percent free-nicotine dust, the 2-percent nicotine-5-percent ammonium sulfate dust, and the nicotine-pine oil-soap spray.

The differences in yields following the insecticidal treatments were not of mathematical significance but there was a tendency for the yields to fall into the same order as did the population counts.

In an effort to ascertain the probable relationship of the number of aphids to the yield, coefficients were calculated indicating the correlation between the preapplication number of aphids for each plot and yield for that plot and the population for each plot 6 days after application and the yield for the same plot. In the former the correlation coefficient was found to be —0.77, which is highly significant, and the latter —0.51, which is also highly significant.

These correlations indicate that the yield was markedly affected by the number of aphids present—the larger the number of aphids, the lower the yield.

With the aid of increased activity of natural agencies, a second application of the insecticides, made 3 days after the postapplication count, effected complete control.

Experiments 3 and 4

Experiments 3 and 4 were conducted on Florida broadleafed mustard that was planted November 4, 1936. They were identical except in the number of applications. In experiment 3 the first application was made on November 24, when the population had a density of about 1 aphid per plant, and 4 applications were made at 14-day intervals. In experiment 4 the applications were all timed on the basis of the aphid populations, which ranged from 1 to 10 per plant, depending upon the size of the plants. The first one was made November 24, when there was about 1 aphid per plant. Applications were required at intervals of 4 to 11 days, the last one being made December 23. The evaluation of the different control schedules in these two experiments was based on the yield of marketable mustard. A summary of the results is presented in table 7.

All insecticidal treatments were effective as compared with the untreated check, which produced no marketable mustard. The derris treatments were significantly superior to the nicotine treatments. There were no significant differences between the dust and spray preparations of the same insecticides.

The yields from the same treatments in the two experiments were almost identical with the exception of that in which derris powder and water was used. Observations indicated that the difference in this case was due to factors other than the treatment.

TABLE 7.—SUMMARY OF YIELD OF MARKETABLE MUSTARD, IN POUNDS, IN SMALL-PLOT FIELD EXPERIMENTS 3 AND 4 AFTER THE APPLICATION OF VARIOUS INSECTICIDES FOR THE CONTROL OF THE TURNIP APHID. BATON ROUGE, LA., FALL OF 1937.

Insecticide	Strength or quantity	Diluent	EXPERIMENT 3 (4 applications)		EXPERIMENT 4 (5 applications)	
			Average quantity applied per acre per application	Yield of Marketable mustard	Average quantity applied per acre per application	Yield of marketable mustard
			Pounds	*Pounds*	*Pounds*	*Pounds*
Check (untreated)			....	0	....	0
Nicotine sulfate*	3 percent nicotine	Hydrated lime	20.3	22.3	22.5	22.3
Derris powder	1 percent rotenone	Tobacco dust and sulfer, 1-1	25.8	27.7	26.5	28.3
			Gallons		*Gallons*	
Nicotine sulfate* Laundry soap	1-1,000 2½ pounds	50 gallons of water	110.2	21.2	115.5	21.3
Derris powder†	2 pounds	do	115.4	28.3	111.3	24.8
Derris powder† Diphenylbutyl-sodium sulphonate	2 pounds 1-1,000	do	112.9	25.3	117.5	25.7
Least significant difference for odds of 19:1			....	3.12	....	4.66

*Containing 40 percent of nicotine.

†Containing 2.9 percent of rotenone.

Field-Control Study

After the superiority of derris insecticides over nicotine mixtures was demonstrated on small-plot field experiments, the suggestion was advanced that the results obtained might have been influenced by a correspondingly greater repellency of the derris insecticides against this species or the repellency of the nicotine mixtures against the natural enemies. To avoid, as much as possible, the effects of any repellant influence either material might have had, a series of experiments was conducted on large field plots in which one dust mixture of each insecticide was used. Furthermore, since derris mixtures had shown promise for the control of other insect pests of turnips and mustard, it was deemed advisable to observe its performance under as nearly normal farming conditions as possible.

This study was conducted during the spring and fall of 1937 and the spring of 1938. It consisted of the comparison of a derris-sulfur-tobacco dust mixture having a rotenone content of 1 percent with a nicotine sulfate-lime mixture containing 3 percent of nicotine in protecting turnips and mustard against insect damage. In each experiment the treated plots were accompanied by an untreated check. The field setup for each experiment consisted of a plot from about one-fourth to one-third of an acre in size for each of the three treatments. The plots in the different experiments were from about 100 feet to one-fourth of a mile apart.

Although 12 experiments were conducted, the aphid populations on the plants in 6 experiments were insufficient to affect either the quality or the quantity of the crop. The other 6 experiments are discussed in this bulletin and referred to as field-control experiments 1 to 6, following the order in which the seeds were planted.

Where three or more applications of the insecticides were made, it was observed that the quality of the crop appeared to be influenced by the insecticidal treatments; the derris seemed to increase the thriftiness of the plants, whereas the nicotine seemed to have stunted them.

Data on the insecticidal applications, crops used, dates of planting and of harvest, and average quantities of insecticide applied per acre per application are presented in table 8.

The relative effectiveness of the treatments was judged on the basis of the yield and value of the crops harvested. Yield estimates were obtained by harvesting four 1/360-acre areas selected at random for each treatment. The crop prices were based on estimates obtained from 10 grocerymen in different parts of the city of Baton Rouge. The samples submitted for price estimates consisted of 4 bunches harvested from each of 10 random areas in each plot. Crop values were obtained by multiplying yields by the average price estimates. The information presented in table 9 illustrates the price variations within, as well as between, treatments. These variations were due both to differences in the quality of crop and to the

TABLE 8.—SUMMARY OF CROP AND INSECTICIDAL DATA ON FIELD-CONTROL EXPERIMENTS AGAINST THE TURNIP APHID, BATON ROUGE, LA., 1937-38.

Experiment	Crop	Planted	Dates of application	AVERAGE ACRE RATE OF APPLICATION		Dates of harvest
				Derris dust mixture	Nicotine sulfate mixture	
				Pounds	*Pounds*	
1	Turnip	Sept. 28	Oct. 14 and 28 Nov. 11 Dec. 2	21.6	24.5	Nov. 29 Dec. 15 Jan. 5
2	Mustard	Oct. 21	Nov. 4, 11, 18 Dec. 1, 15	21.0	22.8	Jan. 3, 4
3	do	Feb. 5	Feb. 16 Mar. 2	33.3	26.2	Mar. 25
4	do	Feb. 17	do	16.8	26.7	Mar. 31
5	do	Mar. 2	Mar. 15	22.9	33.2	April 8
6	Turnip	do	do May 14	23.3	35.2	April 22

demand for the crop by the customers of any particular groceryman. The data obtained on yield and value of the crops are presented in table 10.

No price data were obtained for the yields given in experiment 1 of table 10. The turnips were graded according to quality. Those treated with the derris dust mixture containing 1 percent of rotenone produced 100 percent good plants; those treated with the 3 percent of nicotine produced 18 percent of plants of good quality, 43 percent of poor quality, and 39 percent of very poor quality (unmarketable). All the plants of the untreated plots were of very poor quality and unmarketable. Although the aphid was abundant, it was not responsible for all the damage. The vegetable weevil (*Listroderes obliquus* Klug) became abundant on both the nicotine and the untreated plots before the harvest was completed and contributed materially to the damage.

Experiment 2 was conducted under the same conditions as experiment 1, and similar damage was caused. The mustard was planted in fields adjoining plots of an earlier planting of turnips which did not become infested until after they had been discarded as an experiment. This setup provided an opportunity for observation on the relative lasting effects of derris and nicotine dust mixtures, the spreading of aphids from old infested plants to younger crops adjoining, and the relative value of the two insecticides in protecting the crops against leaf-eating species, principally the vegetable weevil.

TABLE 9.—PRICES QUOTED BY 10 GROCERYMEN FOR MUSTARD PRODUCED IN FIELD CONTROL OF THE TURNIP APHID, EXPERIMENT 2, BATON ROUGE, LA., FALL OF 1937.

INSECTICIDE	ESTIMATED PRICES PER DOZEN BUNCHES OF MUSTARD OBTAINED FROM 10 GROCERYMEN										Average price per dozen bunches
	A	B	C	D	E	F	G	H	I	J	
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
Derris (1 percent rotenone) sulfur-tobacco dust	30	30	30	30	40	35	40	30	40	50	35.5
Nicotine sulfate (3 percent nicotine) hydrated lime	25	15	0	15	25	25	30	25	30	25	21.5
Untreated	0	0	0	0	0	0	0	20	20	20	6.0

TABLE 10.—SUMMARY OF YIELD, PRICES PER DOZEN BUNCHES OF TURNIPS AND MUSTARD AND MONETARY RETURNS PER ACRE IN 6 EXPERIMENTS IN FIELD CONTROL OF THE TURNIP APHID AT BATON ROUGE, LA., FALL OF 1937 AND SPRING OF 1938.

Experiment	CROP	YIELD IN BUNCHES PER ACRE			AVERAGE PRICE PER DOZEN BUNCHES			VALUE PER ACRE		
		Untreated check	3-percent nicotine dust	1-percent rotenone derris dust	Untreated check	3-percent nicotine dust	1-percent rotenone derris dust	Untreated check	3-percent nicotine dust	1-percent rotenone derris dust
		Dozen	*Dozen*	*Dozen*	*Cents*	*Cents*	*Cents*	*Dollars*	*Dollars*	*Dollars*
1	Turnips	521.0	850.0	937.0	....	....	....	......	......	......
2	Mustard	255.0	682.5	997.5	6.0	21.5	35.5	15.30	146.74	354.11
3	do	825.0	840.0	1,200.0	25.5	31.5	35.5	210.38	264.60	426.00
4	do	547.5	577.5	847.5	21.8	24.5	28.7	119.36	141.49	243.23
5	do	277.5	285.0	247.5	26.5	25.0	28.0	73.54	71.25	69.30
6	Turnips	832.5	1,207.5	1,117.5	25.0	28.5	31.5	208.13	344.14	352.01

Figure 7 shows mustard adjoining a stand of old turnips which had been treated with a derris dust mixture containing 1 percent of rotenone. No killing or thinning of the mustard plants by the aphid occurred on the rows next to the old turnips. Figure 8 shows comparable plantings treated with a 3-percent nicotine dust mixture, where the aphid caused a poor stand of plants on the rows next to the old turnips. The old turnips had received two applications of the nicotine insecticide, the last one being made on October 28—one week after the mustard was planted. The plants on the plot treated with the derris dust mixture appeared to be somewhat thriftier than those on the plot treated with the nicotine dust mixture, although there was little or no difference in the fertility of the soil on which the mustard was grown. Figure 9 shows the untreated check of the same two experiments with no mustard plants left on the rows next to the old turnips and but few plants and these of poor quality, on the more distant rows.

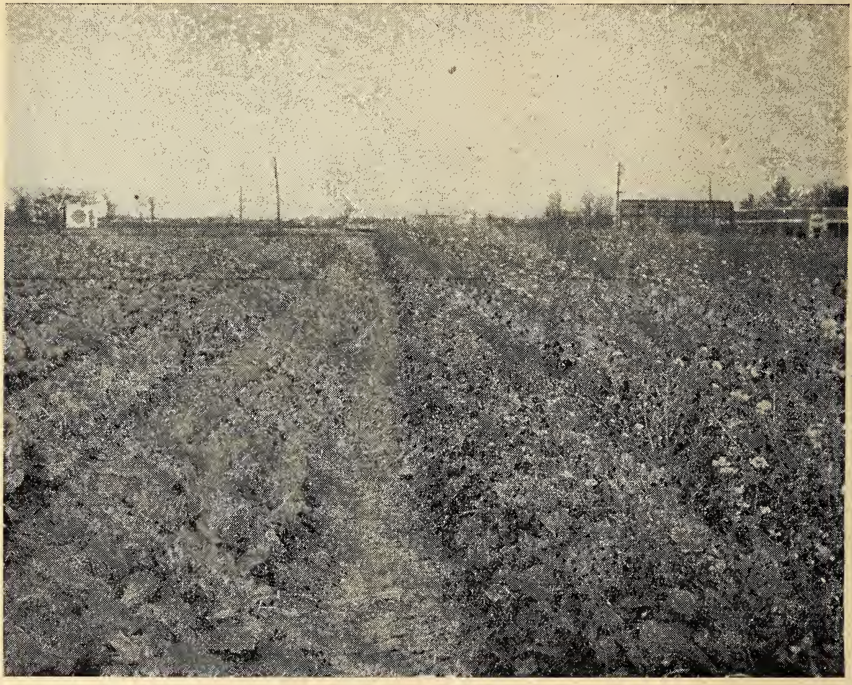

FIGURE 7.—Mustard, at Left, Planted October 21, 1937, Treated With Derris Dust Mixture, Adjoining an Older Planting of Turnips That Had Also Been Treated With Derris.

Figure 10 illustrates the protection against leaf-eating species provided by five applications of a derris dust mixture containing 1 percent of rotenone and a 3-percent nicotine dust mixture. The derris dust mixture gave perfect protection, whereas the plot treated with the nicotine dust mixture was only a little better than the untreated check. The difference between the nicotine treatment and the untreated check may have been influenced by the greater volume of foliage on the nicotine-treated plot on which insects could feed.

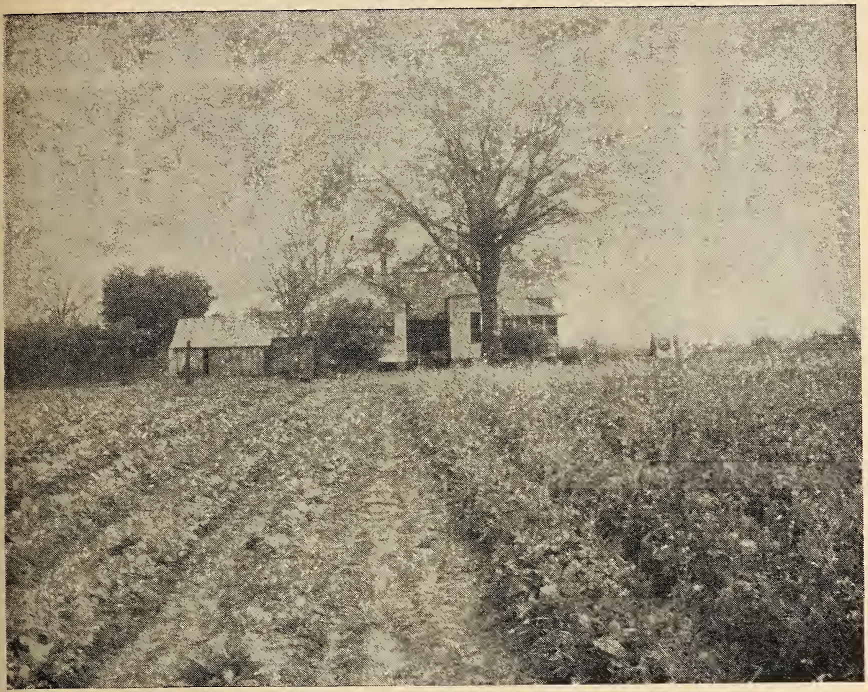

FIGURE 8.—Mustard, at Left, Planted October 21, 1937, Treated With Nicotine Dust Mixture, Adjoining an Older Planting of Turnips That Had Also Been Treated With Nicotine.

Time to Apply Insecticides

It is very important that the first application of the insecticide be made on the plants when they are very small (Fig. 11), as soon as the plants are up to a good stand, because the crops are subject to attack from this time until they are harvested. If the first application of the insecticide is delayed until after the plants have become severely injured by the turnip aphid (Fig. 12), the injured plants may be killed or stunted, so that control not only becomes more difficult and expensive, but the production of a profitable crop may not be possible. Subsequent applications should be made at intervals of 7 to 14 days, depending on the severity of the infestation.

Two or three applications of insecticides are normally required to protect radishes from attack by this aphid in the winter-vegetable-producing areas of the South, three or four for mustard, and five or six for turnips.

When the developmental period of a crop is prolonged by unfavorable growing conditions, especially by low temperatures, under which the aphid is usually most destructive, additional applications may be required.

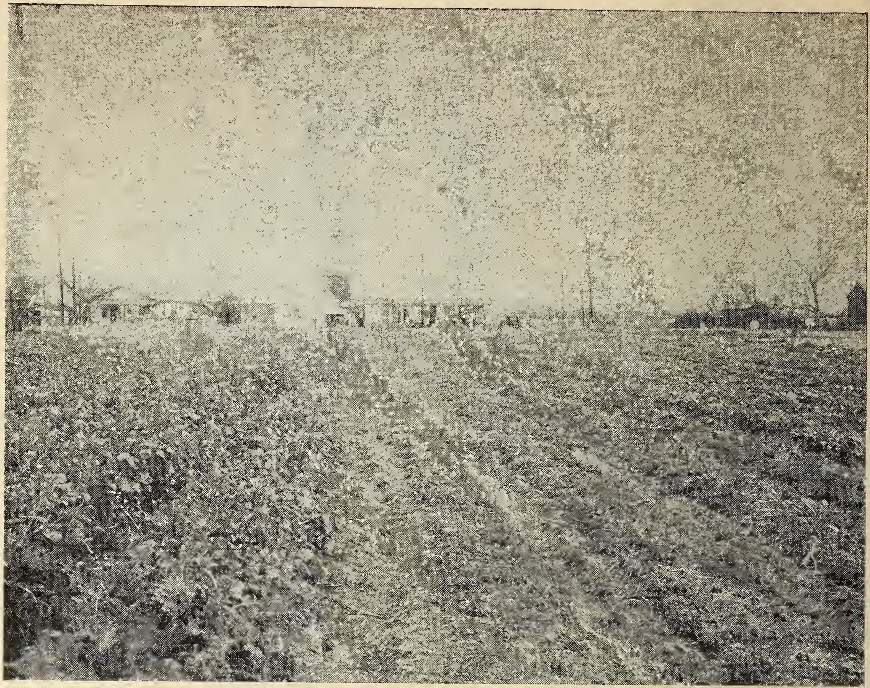

FIGURE 9.—Untreated Mustard Planted October 21, 1937, Adjoining an Older Planting of Untreated Turnips. Only a Few Stunted Mustard Plants May Be Seen at Extreme Right. Weeds Are Growing Next to the Turnips Where Plants Have Been Killed.

For best results, the derris dust should be applied during the late afternoon, early evening, or early morning, while the atmosphere is calm and preferably while the plants are moist. Furthermore, the dust mixtures should be applied in such a way as to cover the plants thoroughly, especially the undersides of the leaves, where most of the aphids are usually concentrated. This can best be accomplished with hand-power, or traction dusting machines. A satisfactory method for hand-gun application is illustrated in figure 6. In this case the crop was planted in two drills 8 to 10 inches apart with the rows spaced uniformly 3½ to 4 feet apart.

Toxicity of Derris and Nicotine to Ladybird Beetles

In the field experiments it appeared that the insecticides affected the natural enemies of the turnip aphid. Cage tests were therefore conducted in an effort to determine whether the derris dust mixture and the nicotine

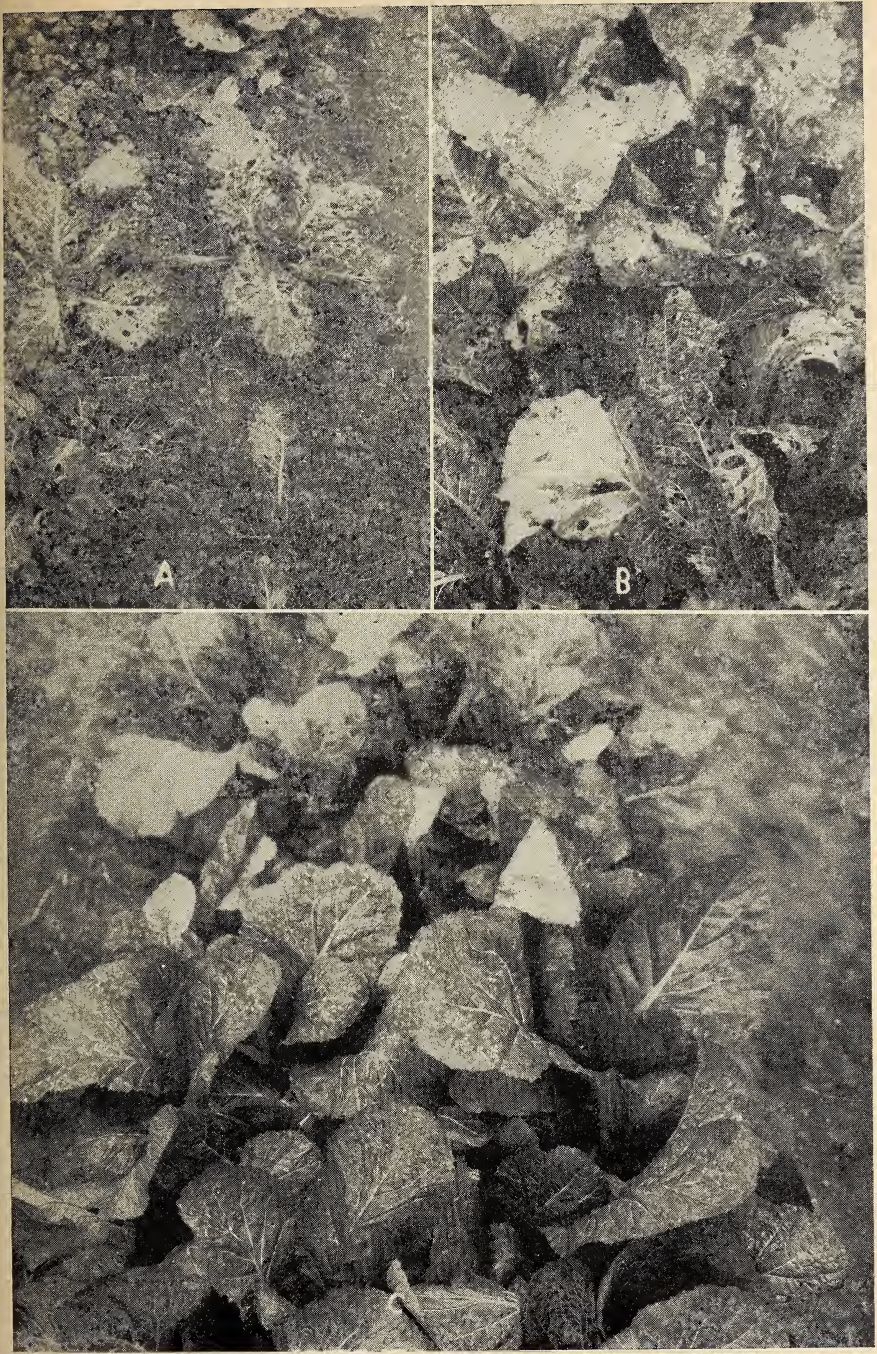

FIGURE 10.—Comparison of Protection to Mustard Against the Turnip Aphid and Leaf-Eating Insects, Especially the Vegetable Weevil: A, Untreated Check; B, Five Applications of Nicotine Dust at 7- to 14-Day Intervals; C, Five Applications of Derris Dust Mixture at 7- to 14-Day Intervals. Baton Rouge, La., 1937.

dust mixture that had been used in the field were either toxic or repellent to the laydbird beetles that are predaceous on the aphid in Louisiana.

The results indicated that the derris dust mixture is not repellent to these beetles, but is toxic, killing a high percentage of those on the treated plants. The nicotine dust mixture also showed little or no repellency, but was considerably less toxic than the derris dust mixture.

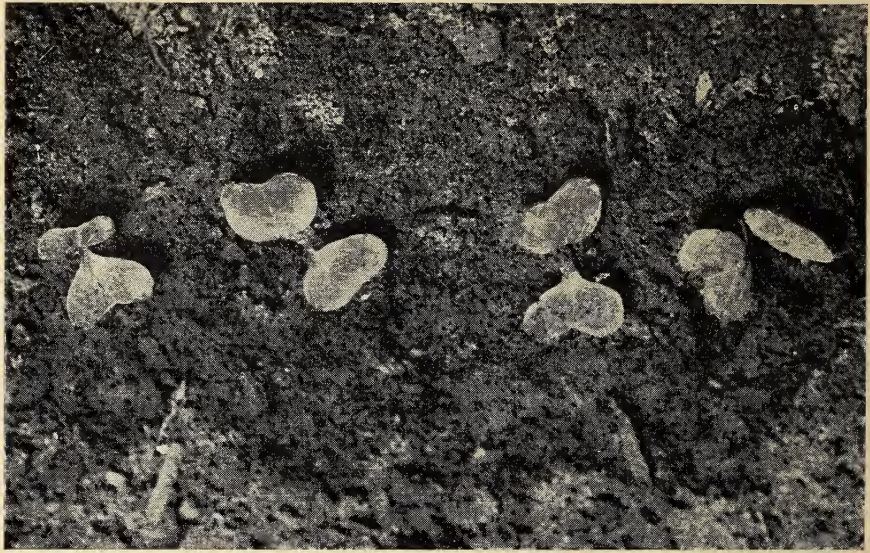

FIGURE 11.—Stage of Growth at Which Plants Should Be Given the First Application of Insecticides for Control of the Turnip Aphid. About Twice Natural Size.

Control of Other Insects by Treatments for the Aphid

Turnips, mustard, and related crops are subject to attack and are often seriously damaged by several other insect pests. One or more of several leaf-eating as well as sucking species may be involved. The more important of these include the fleabeetles *Phyllotreta vittata* (F.), *P. aeneicollis* (Cr.), and *P. liebecki* Schaeff., the vegetable weevil (*Listroderes obliquus* Klug), the imported cabbage worm (*Pieris rapae* (L.)), the cabbage looper (*Autographa brassicae* (Riley)), the larvae of the diamondback moth (*Plutella maculipennis* (Curt.)), the cabbage webworm (*Hellula undalis* (F.)), the cross-striped cabbage worm (*Evergestis rimosalis* (Guen.)), the garden webworm (*Loxostege similalis* (Guen.)), the southern cabbage worm (*Pieris protodice* (Bdv. & Lec.)), the spotted cucumber beetle (*Diabrotica duodecimpunctata* (F.)) and the banded cucumber beetle (*D. balteata* Lec.). Sucking species other than the turnip aphid include the cabbage aphid (*Brevicoryne brassicae* (L.)), the green peach aphid (*Myzus persicae* (Sulz.)), the harlequin bug (*Murgantia histrionica* (Hahn)), the southern green stinkbug (*Nezara viridula*

(L.)), the false chinch bug (*Nysius ericae* (Schill.)), and the tarnished plant bug (*Lygus pratensis oblineatus* (Say)).

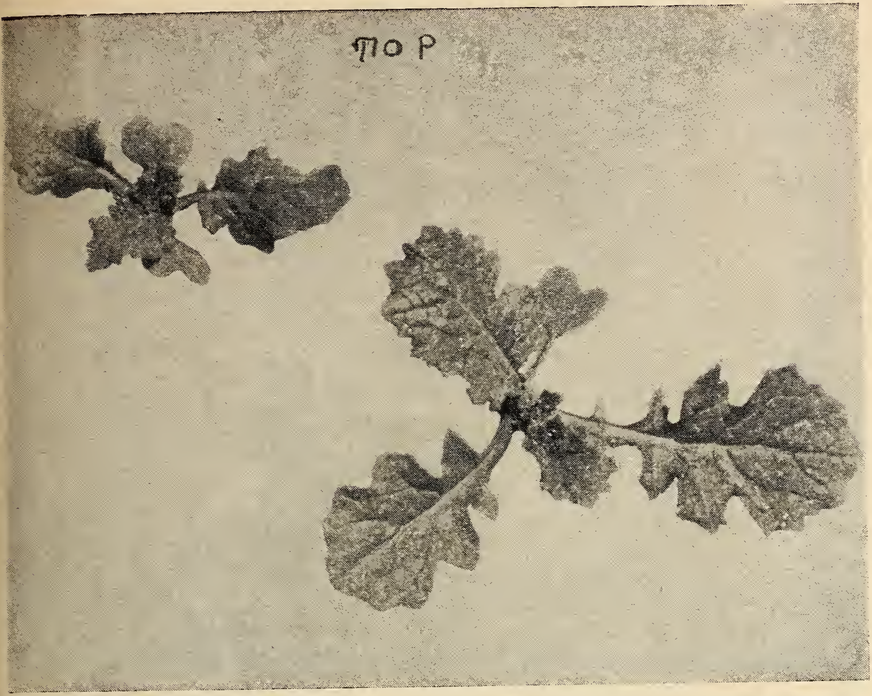

FIGURE 12.—INFESTED MUSTARD PLANT AT LEFT, UNINFESTED PLANT OF SAME AGE AT RIGHT. ABOUT TWICE NATURAL SIZE. WHEN THE FIRST APPLICATION OF INSECTICIDES FOR TURNIP APHID CONTROL IS DELAYED UNTIL THE PLANTS REACH THIS STAGE OF GROWTH, THE INFESTED PLANTS MAY BE KILLED, OR STUNTED TO SUCH AN EXTENT AS TO PREVENT THE PRODUCTION OF A PROFITABLE CROP.

The derris dust mixture containing 1 percent of rotenone effectively controlled the vegetable weevil (when applied at intervals of 7-14 days), the striped fleabeetle, the imported cabbage worm, the cabbage looper, and the larvae of the diamondback moth. It did not control the false chinch bug, the green peach aphid, or the cabbage aphid. No definite explanation can be advanced for its failure to control the green peach aphid and the cabbage aphid in experiments conducted thus far. It may be conjectured, however, that this material is not specific for these two species of aphids, thus providing another illustration of the phenomenon of specificity of insecticides. The other insects that occasionally infest turnip and mustard plants were not present in sufficient numbers in any of the experiments to enable their reaction to the insecticides to be determined.

Cultural Practices

For successful production of crops that are favorite hosts of the turnip aphid, the plants must be kept thrifty from the time they come up until they are harvested. The first prerequisite for this is a well prepared, fertile seedbed. The employment of several other cultural or farming practices aids materially. Among the more important ones are the following:

(1) The seed should be planted in drills. Two drills 8 to 10 inches apart with the rows spaced uniformly 3½ to 4 feet apart have proved very satisfactory. This permits cultivation, which helps to conserve soil moisture during dry weather, stimulates plant growth, and hastens maturity. The plants also tend to grow erect when good stands are obtained (Fig. 13), thus permitting the effective application of insecticides. An undesirable practice employed in some sections is the broadcasting of the seed on beds of varying widths (Fig. 14). The undesirability of this practice cannot be overemphasized for the plants produce spreading leaves which favor the insect and hinder the application of the insecticides, the plants cannot be cultivated, and excessive quantities of insecticides are necessary for an effective application. It is necessary that the rows of plants be of a uniform distance apart in order that the outlets or nozzles on the duster or sprayer can be arranged so as to insure a thorough coverage of each

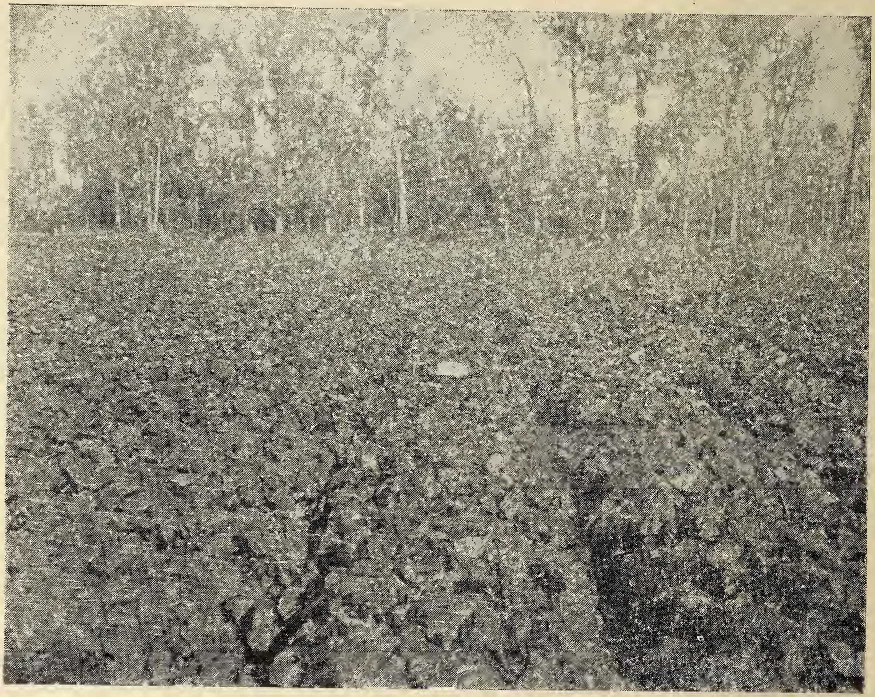

FIGURE 13.—FIELD OF TURNIPS PLANTED TWO DRILLS PER ROW AND TREATED WITH DERRIS DUST MIXTURE. BATON ROUGE, LA., 1936. (THE HAT SHOWN IS ON A CAMERA CASE 15 INCHES HIGH.)

row by the insecticide. Rows spaced unequally apart result in some of the plants being missed by the insecticide.

(2) The crop should be harvested as soon as possible. This shortens the period during which insecticidal protection has to be provided.

(3) Crop refuse should be destroyed immediately by feeding it to livestock or plowing it under. This eliminates a common source of the winged form which may infest young crops in the vicinity.

(4) Crop rotation should be practiced where possible. Host crops should not be planted on land from which an infested crop has just been removed, and they should be planted as far as possible from growing crops that are hosts of the species (Fig. 9, p. 30).

(5) A nitrogenous fertilizer applied at the rate of 100 to 200 pounds per acre soon after the plants are up increases the rate of growth at a time when the plants are most subject to attack by the aphid, thus enabling them to withstand the attack better.

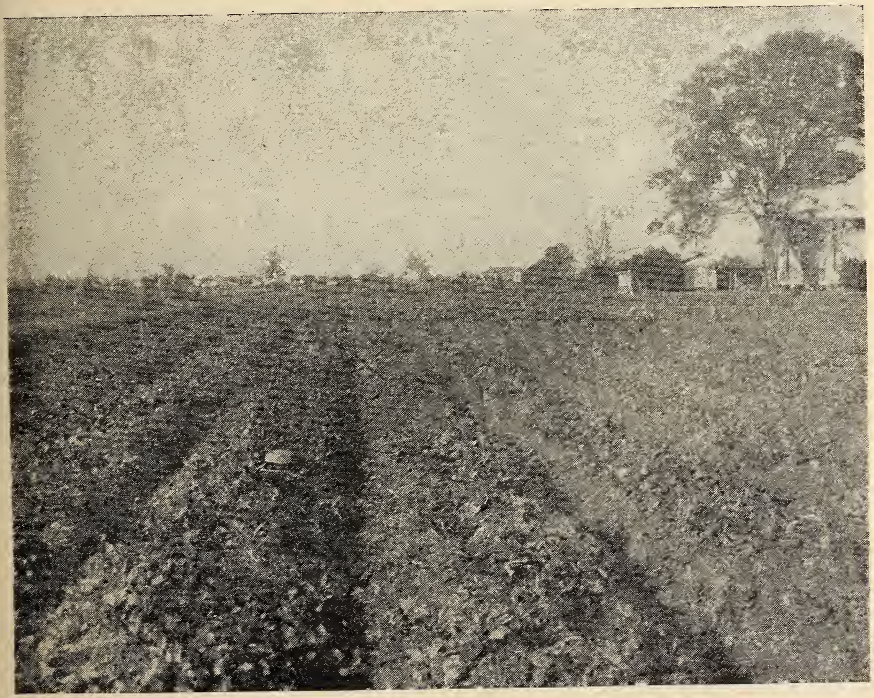

FIGURE 14.—Field of Turnips Planted Broadcast Which Received No Insecticidal Treatment. Baton Rouge, La., 1936.

SUMMARY

The turnip aphid (*Rhopalosiphum pseudobrassicae* (Davis)) is the major insect pest of turnips, mustard, and radishes throughout the South. Nicotine as a dust or spray has been used commonly as an insecticide for the turnip aphid. Since the results obtained with nicotine varied widely in different localities and in the same locality under different conditions, a systematic study of the insect was begun during 1932 in an effort to develop more satisfactory control measures.

The turnip aphid is widely distributed in North America, and has also been reported as occurring in South Africa, Japan, and Argentina.

The turnip aphid prefers young plants or the new growth of older plants upon which to feed.

Life-history studies performed in lantern globe cages set over flowerpots containing turnip or mustard plants showed (1) that where desirable food, consisting of turnip or mustard plants, was supplied to the aphids, a total of 46 generations as a maximum and 16 generations as a minimum could be reared in an outdoor insectary within a period of 12 months, (2) that the growth or developmental period ranged from 4 to 21 days, (3) that the number of young produced by each female ranged from none to 123, (4) that the number of days during which the females continued to bear young ranged from none to 43, (5) that the adult life of the females ranged from 7 to 66 days, (6) that the production of winged individuals was closely associated with a deficiency in the quantity of food material in the host plant or the inability of the individuals to obtain sufficient food for optimum growth because of the reduced succulency of the plant, and (7) that young plants appeared to supply optimum food requirements for the aphids.

In special observations of the molting habits of the turnip aphid, it was found that four molts appear to be the normal number, although some nymphs molted only three times and a few molted five times.

When food plants of approximately the same age were supplied throughout the year the various stages of the life history were influenced markedly by existing temperatures. There was a significant negative linear relationship between the temperature averaged at 2-hour intervals and the length of life. This relationship was much more pronounced, however, when the data taken on each individual were assembled by the month in which such individuals were born than when assembled on the basis of the average temperature for their life periods.

The turnip aphid greatly prefers plants belonging to the genus *Brassica.*

The cabbage aphid and the green peach aphid are often associated with, and may be mistaken for, the turnip aphid.

Although natural enemies, including insects, birds, and diseases, proved to be valuable aids in reducing the numbers of the turnip aphid, it has been necessary to apply artificial remedies, especially during the period when the aphid is most abundant.

Laboratory experiments disclosed that in the presence of high humidity and low temperature pine-tar soap, at a dilution of 5 pounds of the soap to 100 gallons of water, killed approximately 90 percent of the aphids, but in the presence of low humidity and high temperature it was necessary to add a 40-percent nicotine sulfate solution at a strength of 1-1,000 in order to obtain a satisfactory kill of the aphids.

Small-plot experiments on replicated plots showed that in general dust mixtures were more satisfactory than sprays, and that a dust mixture containing 3 percent of nicotine and a derris root mixture containing 1 percent of rotenone with equal parts of finely ground tobacco dust and 300-mesh dusting sulfur as a diluent were the most promising insecticides tested. It was demonstrated that the derris dust mixture remained effective for a period of approximately 1 week after it was applied.

A field-control study confirmed the results of the small-plot field experiments and further showed that, as judged by yield and monetary value, the crop of plants produced where the derris dust mixture was used was worth more than that produced where the plants were treated with an equal number of applications of the nicotine dust mixture. Three or more applications of the nicotine dust mixture appeared to have a stunting effect on the plants, whereas the derris dust mixture appeared to increase the vigor of the plants.

Cage tests indicated that the derris dust mixture containing 1 percent of rotenone, as used against the turnip aphid, is rather toxic to ladybird beetles, one of the principal groups of natural enemies of the turnip aphid, but that the nicotine dust mixture containing 3 percent of nicotine was less toxic than the derris.

Incidental observations during the progress of insecticide tests against the turnip aphid demonstrated that, in addition to giving a satisfactory degree of control against this pest, the derris dust mixture containing 1 percent of rotenone effectively controlled several species of leaf-feeding insects which attack turnip and mustard plants.

The following cultural practices were found to be especially valuable in producing successful crops in the presence of turnip aphid infestations: (1) Planting in drills with rows spaced uniformly in such a manner as to aid in the application of insecticides, (2) early harvesting of the crop, (3) complete harvesting of the crop, (4) crop rotation, where agronomically feasible, and (5) the application of a nitrogenous fertilizer at a time when the plants are small.

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LOUISIANA BULLETIN NO. 366 JUNE, 1943

EPERYTHROZOONOSIS IN CATTLE AND SHEEP OF LOUISIANA, PRELIMINARY REPORT

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Eperythrozoonosis in Cattle and Sheep of Louisiana, Preliminary Report*

By R. Jensen

INTRODUCTION

While studying anaplasmosis in splenectomized cattle, beginning September, 1942, an extraneous organism has been encountered which parasitizes the erythrocytes and which tends to complicate anaplasmosis under experimental conditions. This organism is tentatively identified as *Eperythrozoon Wenyoni* which has been described from the blood of cattle by Adler and Ellenbogen[1] in Palestine and by Neitz[2] of South Africa. In the region of Beltsville, Lotz and Yiengst[3] observed eperythrozoon organisms in the blood of a calf that had been inoculated with blood from an animal which originated in Louisiana. Obviously it was not known if this donor animal had become infected while in Louisiana or whether infection occurred subsequent to leaving the state. While studying anaplasmosis in Louisiana, Dikmans[4] in 1932 observed blood from splenectomized cattle that was heavily infected with small organisms, which were interpreted as being possible developmental forms of anaplasma. It is reasonable to assume that he saw eperythrozoa. Since an ovine species, *Eperythrozoon ovis,* has also been described by Neitz, Alexander, and Du Toit[5] from sheep of South Africa, it was considered worthwhile to determine if the ovine strain were also present in native sheep of Louisiana. With a minimum of survey work, the ovine strain was located. Both bovine and ovine strains were compared morphologically with *Eperythrozoon coccoides, Haemobartonella muris,* and *Bartonella bacilliformis,* each the type species of its respective genus, as supplied by Dr. David Weinman of Harvard University Medical School. Although not proved, it is reasonably assumed that these organisms occurring in sheep and cattle of Louisiana are similar if not identical to those of Africa; namely,

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* Presented at the annual meeting of the Louisiana Veterinary Medical Association February 11, 1943.

[1] Adler, S. and Ellenbogen, V. A note on two new blood parasites of cattle, *Eperythrozoon* and *Bartonella.* Journ. Comp. Path. and Therap., Vol. 47, No. 3, pp. 219-221, Sept., 1934.

[2] Neitz, W. O. Eperythrozoonosis in cattle. Onderstepoort Journ. of Vet. Sc. and An. Ind., Vol. 14, No. 1, pp. 9-30, 1940.

[3] Lotz, J. C. and Yiengst, M. J. "Eperythrozoonosis" in cattle in United States. N. A. V., Vol. 22, No. 6, June, 1941.

[4] Dikmans, G. VI The morphology of anaplasma. Journ. A. V. M. A., Vol. LXXXIII, N. S., Vol. 37, No. 2, pp. 203-213, Aug. 1933.

[5] Neitz, W. O.; Alexander, R. A.; and Du Toit, P. J. *Eperythrozoon ovis* (sp. nov.) infection in sheep. Onderstepoort Journ. of Vet. Sc. and An. Ind., Vol. 3, No. 2, Oct., 1934.

Eperythrozoon Weynoni of cattle, and *Eperythrozoon ovis* of sheep. Dr. David Weinman concurs in the identification.

To date all observations on the bovine strain have been made on splenectomized cattle in which the disease was contracted naturally and by blood inoculation. No opportunity has arisen to study the disease in pure form in unoperated cattle. Observations on the ovine strain have been made on cases induced by blood inoculations in unoperated feeder lambs one year of age.

The importance of this disease under field conditions has not been determined, but it does have considerable significance in experimental pathology.

MATERIALS AND METHODS

Cattle used in this investigation were native to Louisiana. Calves were of dairy and beef breeds obtained from local dealers or, more frequently, from the university herds. These calves were maintained in small feed lots until approximately three months of age when they were splenectomized. Inoculation was within one month following operation or as soon as recovery had occurred. Calves were splenectomized for the purpose of obtaining animals uniformly susceptible to anaplasmosis.

The source of inoculum from which the bovine strain of eperythrozoa was originally obtained was two aged steers, one eight years of age and the other seven years of age, that had been born and raised at the university pastures. Both of these animals were known to have recovered from anaplasmosis. 10 cc. of their blood were inoculated into a splenectomized calf. Eperythrozoonosis developed during the incubation period of anaplasmosis. Both eperythrozoa and anaplasma were propagated by subinoculations.

Merino sheep used in this investigation were also native to Louisiana and were obtained from the university flock. Except for the original isolation of the ovine strain, all observations were made on unoperated feeder lambs approximately one year of age.

After finding eperythrozoa in cattle, the plan was to survey the sheep population to determine the presence or absence of the ovine strain. This was to be accomplished by injecting composite samples of mature sheep blood into susceptible sheep until the organism was located or until several flocks of sheep had been sampled and found negative. Two animals known to be susceptible were obtained by splenectomizing two yearling sheep. Stained blood smears from these two sheep were carefully examined at two-day intervals. Thirty days following the operation, eperythrozoa had been observed at no time; it was then concluded that the splenectomized sheep were not in a state of premunition and, therefore, were susceptible. The first composite sample of blood taken from ten mature ewes from the university flock and inoculated into the splenectomized sheep proved to be infective. This isolated ovine strain was then propagated by subinoculations into normal, unoperated yearling feeder lambs and used in all later studies on sheep.

Blood smears, erythrocyte counts, and temperature readings were made at two- and three-day intervals preceding and following inoculations. During active infections these were made daily. Numerous stains were tried. The best differentiation was obtained with Giemsa stain. The routine technique employed consisted of fixation of air dried blood smears in methyl alcohol, or equal parts of methyl alcohol and ether for ten minutes, or in May-Grunwald fixing agent for three minutes. Staining was accomplished by submerging smears for thirty minutes in Giemsa solution buffered to pH 7.0-7.2.

Diagnosis was made by demonstrating the organism in stained blood smears.

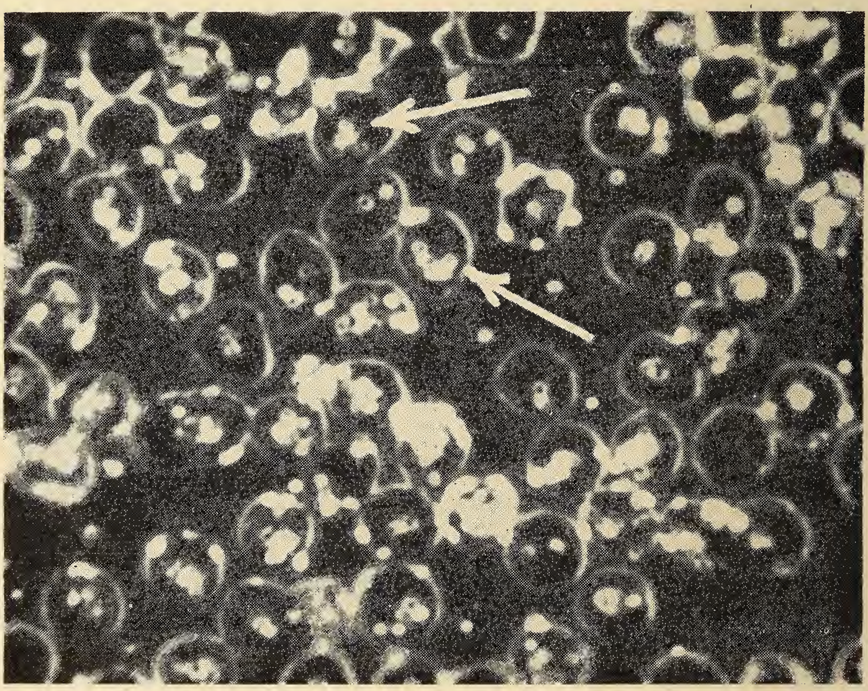


PLATE I

Photomicrograph with darkfield illumination of eperythrozoa in blood of unoperated sheep. x 950 Arrows point to organisms situated on erythrocytes.

CLINICAL MANIFESTATIONS IN CATTLE AND SHEEP

In naturally infected splenectomized calves, the infection increased rapidly in intensity, as determined by the number of infected erythrocytes, until after four to five days essentially all erythrocytes were heavily infected. During the infection, the temperature fluctuated between normal and 106° F. The erythrocyte count descended rapidly from 8,000,000 per cmm. to as low as 1,500,000 per cmm. Accordingly, the visible membranes were pale and respiration was accelerated. No fatalities have been observed. Recovery was gradual, but relapses occurred. Several cases, resulting from inoculation of splenectomized calves with blood from animals recovered from anaplasmosis, have been observed in which eperythrozoa occurred in the blood during the incubation period of anaplasmosis. In mixed infections anaplasma rapidly displaced the eperythrozoa. No opportunity has yet arisen to study uncomplicated cases in unoperated calves or adult cattle.

In sheep all clinical observations were made on unoperated feeder lambs approximately one year of age in which the infection had been induced by intravenous inoculation of heavily infected blood. In one experiment six yearling lambs, selected at random from a feed lot, were inoculated intravenously each with 10 cc. of heavily infected blood. After an incubation period which varied from 3–21 days all six lambs developed the disease. The degree of infection varied from mild to severe and symptoms varied accordingly. Anemia ranged from mild to grave. In the most severe case, the erythrocyte count descended rapidly from 9,000,000 per cmm. to 2,500,000 per cmm. Visible membranes were pale and slightly icteric. Respiration was accelerated. During the first part of the heavy infection, the temperature curve was characterized by extreme fluctuation. All six animals recovered.

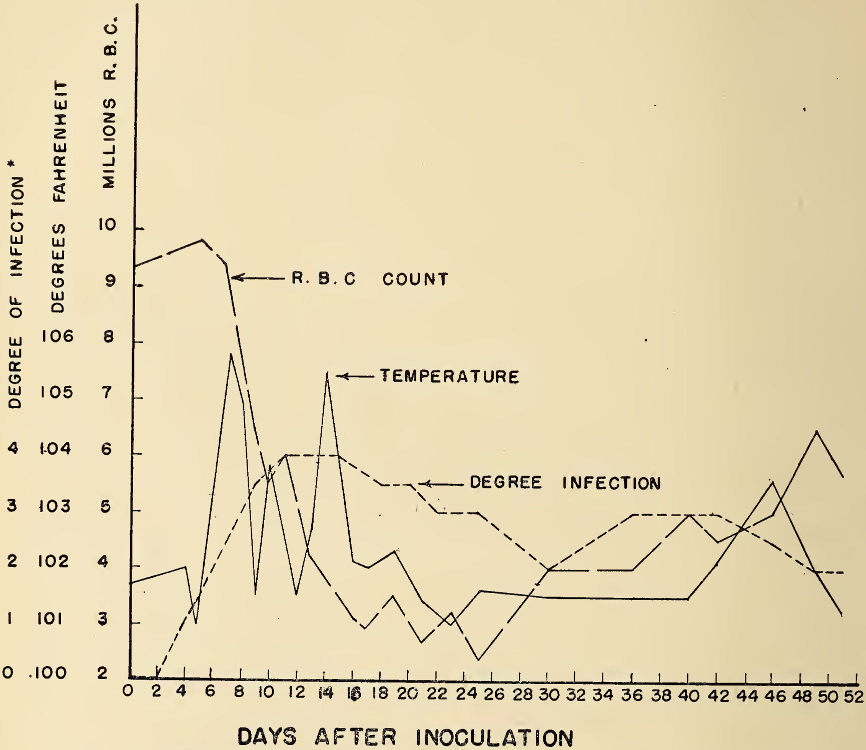
The degree of infection, temperature, and erythrocyte count for the most severely infected sheep, No. 253, is shown in curves in Figure 1. Table 1 is a tabulation of the data pertaining to the six individual sheep during the infection. This experiment was repeated on another lot of six unoperated feeder lambs in which the disease was manifested by a similar range of severity, and by similar symptoms and blood changes.

TABLE I. Individual Records of Six Unoperated Sheep Inoculated Intravenously with Eperythrozoa.

Sheep No.	Incubation Period (Days)	Preinfection R. B. C. Count	Lowest R. B. C. Level Reached	Duration of Demonstrable Infection (Days)	Highest Infection Temperature
253	3	9,000,000	2,500,000	65	105.7
257	3	10,000,000	6,000,000	16	103.9
274	4	10,500,000	6,000.000	18	106.1
277	8	8,500,000	6,000,000	15	104.8
280	3	10,500,000	4,500,000	27	105.6
286	17	8,000,000	6,500.000	6	104.0

THERMAL DEATH POINT FOR EPERYTHROZOA

In experimental anaplasmosis, it is desirable to have a source of inoculum that is uncomplicated with other organisms, including eperythrozoa. An attempt was, therefore, made to separate the two. Rees,[6] attempting to establish the thermal death point for anaplasma, obtained variable results. In one trial the anaplasma survived 60° C. for ten minutes; in another trial they were killed at 48° C; and in still others they survived at 48° C. Thus, the range for anaplasma appears to be wide.



* 0...4= DEGREES OF INFECTION, VARYING FROM NONE TO SEVERE.

Figure 1.

An experiment was designed on this basis to determine the thermal death point of eperythrozoa. The sheep strain was employed because sheep are more available as experimental animals. The blood was heated in 2 cc. quantities in test tubes submerged in a Wasserman bath. Great care was exercised to insure that all blood to be used in each inoculum was heated to the required temperature. The blood was introduced into test tubes by means of suitable pipettes. The top of each tube, which projected above the water bath, was flamed to prevent mixture of unheated blood with heated portions. By previous trials it was determined that two minutes were required to bring the 2 cc. quantity of blood to the temperature of the water bath. The blood samples, therefore, were in the water bath for a total of twelve full minutes. Heated and control samples were injected intravenously. Data of this experiment are given in Table II.

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[6] Rees, C. W. The effect of exposure to different degrees of temperature on the etiological agent of bovine anaplasmosis and piroplasmosis. Journ. Parasit., Vol. 23, No. 2, April, 1937.

TABLE II

Sheep No.	Temperature Degrees C.	Time Heated Minutes	CC. of Inoculum	Reaction*
225	45	10	10	Infected 4/1/43
260	48	10	10	Infected 4/8/43
265	50	10	10	Not infected
283	54	10	10	Not infected
285	room	..	10	Infected 3/29/43
295	room	..	10	Infected 3/25/43

*Inoculations made 3/24/43.

From this limited number of trials, it is seen that the thermal death point for ovine eperythrozoa is greater than 48° C. and less than or equal to 50° C. when heated for ten minutes which is within the same range as established by Rees for bovine anaplasma. Therefore, the application of heat *in vitro* to inoculum containing anaplasma and eperythrozoa probably cannot be used to separate either infection from the other.

CROSS INOCULATION TESTS

Two splenectomized calves known to be susceptible to the bovine strain were inoculated intravenously each with 10 cc. of defibrinated blood from an infected sheep. Daily examinations were made of them for a period of thirty days. At no time did eperythrozoa appear in blood smear preparations. Subsequently, both calves were inoculated with the bovine strain and both contracted the disease.

Likewise, two sheep were inoculated with infected calf blood. During a period of sixty days no eperythrozoa were demonstrated in blood smears. Subsequently, these two sheep were inoculated with the sheep strain and both developed an infection. However, a calf inoculated with blood from these two sheep developed eperythrozoonosis after an incubation period of eighteen days. Thus, the bovine strain was maintained in a viable condition in the sheep. The above tests indicate an interspecial non-susceptibility which is the basis for establishing separate species for cattle and sheep.

TRANSMISSION

Previous investigators 1, 2, 3, 4, 5, 6, have suspected natural transmission to be accomplished by arthropod vectors. By none has this been proved. In the present studies all artificially induced cases were by blood inoculations. Natural spread of the disease has been observed frequently among calves. During fly season the infection spread rapidly when non-infected calves were maintained in pens with infected or carrier calves. Biting flies were abundant. A few lice were observed. No insect transmission studies were attempted.

CONCLUSIONS

1. Eperythrozoonosis exists in native cattle and sheep of Louisiana.

2. In unoperated sheep the disease is characterized by a varying degree of anemia and high, but fluctuating, temperature.

3. The thermal death point of eperythrozoa of sheep is greater than 48° C. and less than or equal to 50° C. when heated for ten minutes.

4. Cattle are not susceptible to eperythrozoa of sheep; and sheep are not susceptible to eperythrozoa of cattle. However, the bovine strain is maintained in sheep when placed there by artificial inoculation.

LOUISIANA BULLETIN NO. 367 JUNE, 1943

CORTICIUM LEAF BLIGHTS OF FIG AND THEIR CONTROL

BY E. C. TIMS AND P. J. MILLS

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Corticium Leaf Blights of Fig and Their Control

By E. C. Tims and P. J. Mills

INTRODUCTION

The fig is one of the more important fruits grown in Louisiana. There are few large orchards, but numerous plantings consisting of from one to a dozen trees are found around homes in the yards or gardens. This is especially true in the southern part of the State where the fig is the most widely grown fruit. It is one of the very few fruits that can be grown successfully in this area. Most of the figs, both fresh and preserved, are consumed locally, but there are a few small canning factories where the fruit is put up for shipment.

Fig trees are easy to grow and in many places are comparatively free of serious diseases and insect pests. But there are a number of diseases which affect them and the most important of these we call "Corticium leaf blights."[1] Many trees may be so badly defoliated as to cause an almost complete failure of the crop. There are three apparently different fungi which cause very similar types of leaf blight. Two of these forms are well known, *Corticium stevensii,* which causes "thread blight" on a number of different plants, and *Corticium* (*Rhizoctonia*) *microsclerotia,* the cause of "web blight" of bean and other plants. The third form which we call *Corticium sp.* is similar in many respects to the common soil fungus, *Corticium solani.*

Not many published reports have been found on the control of fig leaf blights, but some control measures have been reported from Florida, Louisiana, and Texas. Bordeaux mixture has been recommended in Texas and Florida, but did not prove effective in early tests in Louisiana. However, under our conditions an arsenite mixture applied during the dormant season gave satisfactory control of the leaf blights.

The results reported in this paper include studies of the fungi which cause leaf blights and methods for their control.

DISTRIBUTION AND ECONOMIC IMPORTANCE

Corticium leaf blights of fig have been reported from Florida by Burger (2)[2] and Weber (18), in Louisiana by Tims (13), and from Texas by Taubenhaus (12). The diseases are widely scattered over the southeastern portion of this State, causing severe damage in some sections and none in others. Along the lower Mississippi River, Bayou Lafourche, and in some of the Florida parishes the diseases are most prevalent, while in the southwestern part of the State, from Opelousas and Lafayette west to the Texas border there is comparatively little infection. Just why the diseases are quite severe on one group of trees, while another group close by remains entirely healthy, has not been determined. But observations made over a period of more than ten years indicate that blights usually do not spread very rapidly unless the trees are rather close together. However, *C. microsclerotia* forms large numbers of small sclerotia which may be readily scattered by wind, splashing rain, or even by birds and insects. This fungus has recently appeared on fig trees in a number of places where they had previously been free of blight.

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[1] The name "Corticium leaf blights" is used throughout this article to include "thread blight" caused by *Corticium stevensii,* as well as leaf blight caused by *Corticium microsclerotia,* and by a *Corticium sp.* The Rhizoctonia stage of these fungi causes most of the injury to the fig trees.

[2] Reference is made by number to "Literature Cited."

Once a fig tree has become infected it usually shows the disease in varying degree of severity for many years. Since only the leaves and fruit are severely damaged by the leaf blighting fungi, a tree may remain infected for years without showing any apparent ill effects, except the annual defoliation. Some infected fig trees have been observed for as long as nine years. If sprayed properly such trees will yield a good crop of figs.

The severity of Corticium blights varies much with the season. When excessive rains come during late June and early July, before the fig fruit ripens, the damage may be severe. Under such conditions, the trees being partially defoliated, the fruit is exposed to the hot sun and most of it does not ripen. Many of the figs may also be attacked just before maturity, after which they either rot or dry out and hang on for some time.

HISTORY OF THE FIG LEAF BLIGHT FUNGI

1. The thread blight fungus, *Corticium stevensii* Burt.

Lack of uniformity in nomenclature makes the history of *Corticium stevensii* somewhat uncertain. Apparently the first description of the fungus in the United States was by Stevens and Hall (10) in 1909. They called the fungus *Hypochnus achroleucus,* which name was later changed to *Corticium stevensii* by Burt (3). Thread blight studies reported by Weber (18) and Wolf and Bach (21) caused some confusion. The former called the causal fungus *C. stevensii (Burt)* and the latter authors considered it to be *C. koleroga* (Cooke) v. Höhn (the causal fungus of the koleroga disease of coffee in the tropics). Other workers (1, 5, 16) compared the thread blight fungus with the coffee disease organism and concluded that they were distinct organisms. For the sake of clarity the name *C. stevensii* will be used throughout this paper to denote the common thread blight fungus prevalent in the southern United States, which is characterized by the presence of brown sclerotia and hyphal threads on the host.

Corticium stevensii is widely distributed over the southern portion of the United States and has been reported on more than 30 different host plants. The fungus is known to have caused severe damage to a number of plants in the sections of the South where favorable conditions of high humidity and temperature obtain during portions of the summer. The fungus was for several years the most destructive parasite of orchards in Florida and Georgia (11). Severe injury was reported on fig in Louisiana (13). *Corticium stevensii* has also caused some defoliation of tung trees and minor injury to several other plants in this State.

2. *Rhizoctonia microsclerotia* Matz. *Corticium microsclerotia* Weber.

This fungus was first described by Matz in Florida (6, 7) where it caused a leaf blight of fig. The distinguishing character of the fungus in nature was the abundant production of small brown sclerotia (.2 to .5 mm. in diameter) superficially attached to the petioles and twigs of the host. Matz also found a basidial stage which he connected with *R. microsclerotia* but the Corticium stage was not actually named until 1939 by Weber (19). The fungus is known in many tropical countries but has only been reported in the southern portion of the United States, where it attacks a wide variety of host plants.

3. Undetermined Corticium.

The undetermined Corticium was first reported by Tims and Mills (17) in 1938 as causing a leaf blight of fig. Later observations indicated that the fungus produced a basidial stage on fig leaves. This form differed from the other two leaf-blighting fungi in the absence of sclerotia or hyphal threads on the host, as well as in certain cultural characters.

Rogers (9) has recently (1943) renamed a number of Corticiums, putting them into the genus Pellicularia. He changed the name of the thread blight fungus *Corticium stevensii* to *Pellicularia koleroga* Cooke. Another of the fig leaf blight fungi, *Corticium microsclerotia,* was grouped with the very common *Corticium solani,* under the name of *Pellicularia filamentosa* (Pat.) Rogers. However, the familiar names will be retained for the fig leaf-blight fungi discussed here.

SYMPTOMS

All three of the leaf blighting fungi produce somewhat similar symptoms on the fig leaves, but they can usually be distinguished by other characters. In southern Louisiana, lesions usually appear on the leaves during late May or early June and may continue to develop until late fall. Typical infection begins at the base of the leaf and spreads in a fan-like manner (Fig. 1, A), with semicircular, necrotic, brown discolored areas on the basal portion of the leaf, while the upper part may remain green. If temperature and humidity are high, infected leaves may be completely destroyed within 48 hours. Diseased fig trees can usually be identified during the summer by the presence of scattered patches of dead

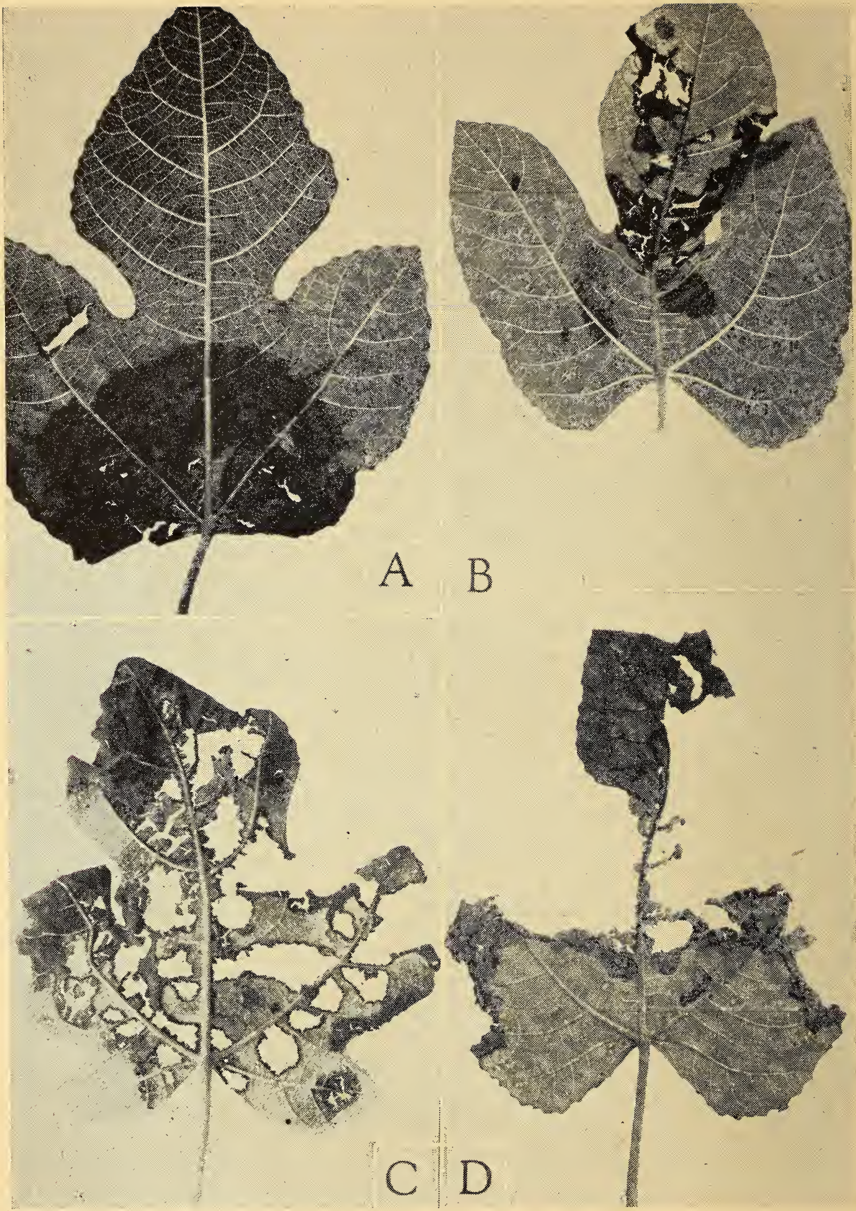

FIGURE 1. Fig leaves showing different types of infection by the blight fungi. A. Typical basal type of infection which may be associated with any of the blight organisms. B. Early infection, showing the irregular shaped brown spots on the leaf. C. The shot-hole effect that is quite commonly associated with the undetermined Corticium. D. Basidial mat of the *Corticium sp.* on healthy portion of ragged leaf.

shriveled leaves. The contact between healthy and diseased leaves often results in rapid spread of the fungus. Fig fruit may be attacked at the same time as the leaves, after which they shrivel and die.

When conditions are not conducive to rapid destruction of the leaf tissue, the basidial mats of *C. stevensii* or the undetermined Corticium (basidial stage of *C. microsclerotia* has not been found on fig in Louisiana) may develop on the lower surface of uninjured leaves or the healthy portions of diseased leaves, on the fruit, and occasionally on the leaf petioles and small twigs. The basidial mat appears as a thin powdery white layer when young, becoming slightly pink to light brown with age. The mats consist of masses of vegetative hyphae on which are borne unicellular basidia with four sterigmata and four basidiospores.

The three fungi may be distinguished on the fig trees by certain characteristic structures. *Corticium stevensii* develops oblong to round, flattened sclerotia (3-4 mm. in largest dimension), usually in groups of two to several, connected by hyphal threads, on one and two-year-old twigs. The immature sclerotia are white and quite soft and cottony (Fig. 2, B). As they mature they turn brown and become hard and compact (Fig. 2, A). The hyphal threads are white when young and become more brown with age. They extend along the small twigs, up the petioles, and on to the bases of the leaves where they divide and gradually become invisible to the naked eye. The leaves may be rapidly killed and become brown and shriveled. In many cases the dead leaves hang by the fungous threads for indefinite periods (Fig. 3). The basidial mats develop on certain leaves which may remain green and apparently healthy for two or three weeks. The

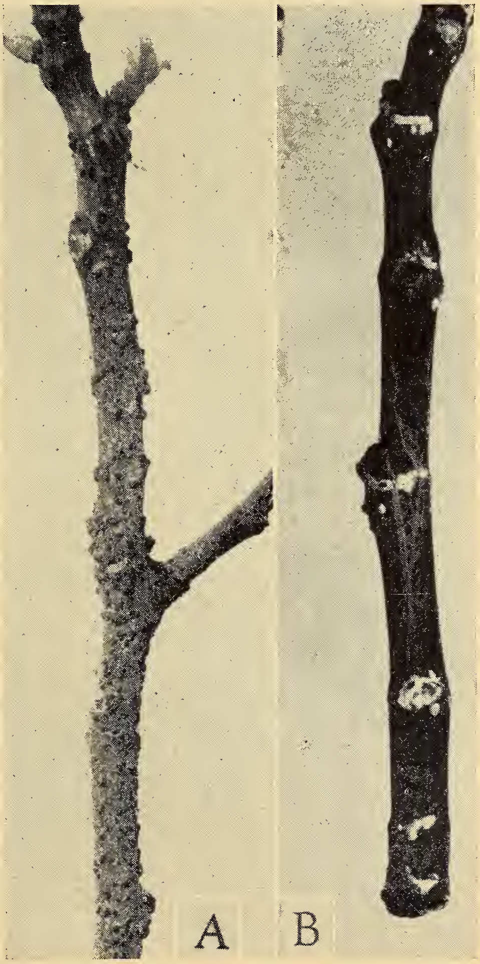

FIGURE 2. *Corticium stevensii* on fig twigs. A. Mature brown sclerotia. B. Immature white sclerotia and hyphal threads.

basidial stage is usually found on the leaves during most of the summer except during prolonged dry periods.

Leaves infected by *C. microsclerotia* and the *Corticium sp.* often differ somewhat from those attacked by *C. stevensii.* Some leaves are infected at the base with brown discoloration spreading in a fan-like manner. But infection is often followed by the appearance of brown necrotic spots, varying much in size and shape (Fig. 1, B). These spots often spread and involve the entire leaf causing a rapid killing, or the dead tissue in the spots may fall out leaving a shot-hole effect (Fig. 1, C). The small, brown sclerotia of *C. microsclerotia* are usually formed in large numbers on infected leaves, twigs, and fruit. Figure 4 shows the sclerotia on twig, leaf petiole, and young fig fruit. They are superficially attached and are readily detached by wind and rain. Basidial mats have not been observed in connection with this fungus, but they are usually found associated with the undetermined Corticium. The basidial mats are often formed on the lower surface of healthy portions of ragged leaves that have been partially killed (Fig. 1, D). Such healthy portions of some leaves may remain alive with the basidial mats on the lower surface for comparatively long periods. The undetermined Corticium may be distinguished from the other leaf blighting forms by the absence of sclerotia or hyphal threads on the host.

SEASONAL DEVELOPMENT

The Corticium leaf blights usually begin to develop in southern Louisiana during the latter part of May or early June, depending upon weather conditions. Prolonged periods of wet weather in June or early July often cause partial defoliation of the trees before the figs ripen. The three leaf-blighting fungi apparently live over on the fig trees. *Corticium stevensii* develops from the sclerotia formed the previous year. The new hyphal threads can be traced back to the sclerotia. Just how the other two forms overwinter is not clear, since there are no sclerotia visible on the twigs during the winter and spring. But the blight fungi apparently live over in the small cracks and crevices in the bark of the fig branches. The very earliest infections appear where the young leaves are in contact with small branches, and definite connection can be traced between the lesion on the leaf and the surface of the twig. As many as twenty such infection centers have been found on one fig tree early in June.

The spread of the disease from leaf to leaf on one tree and from tree to tree has been studied. Most of the spread within the tree takes place in two ways: contact between healthy and diseased leaves; and, in the case of *C. microsclerotia,* scattering of the small sclerotia by wind, rain, and possibly insects. Dead leaves fall upon healthy ones and cause new infections. The presence of *C. microsclerotia* can often be determined when no sclerotia are visible by the appearance of numerous small spots on the leaves below an old infection center. The sclerotia fall on the leaves below and produce the numerous small brown spots.

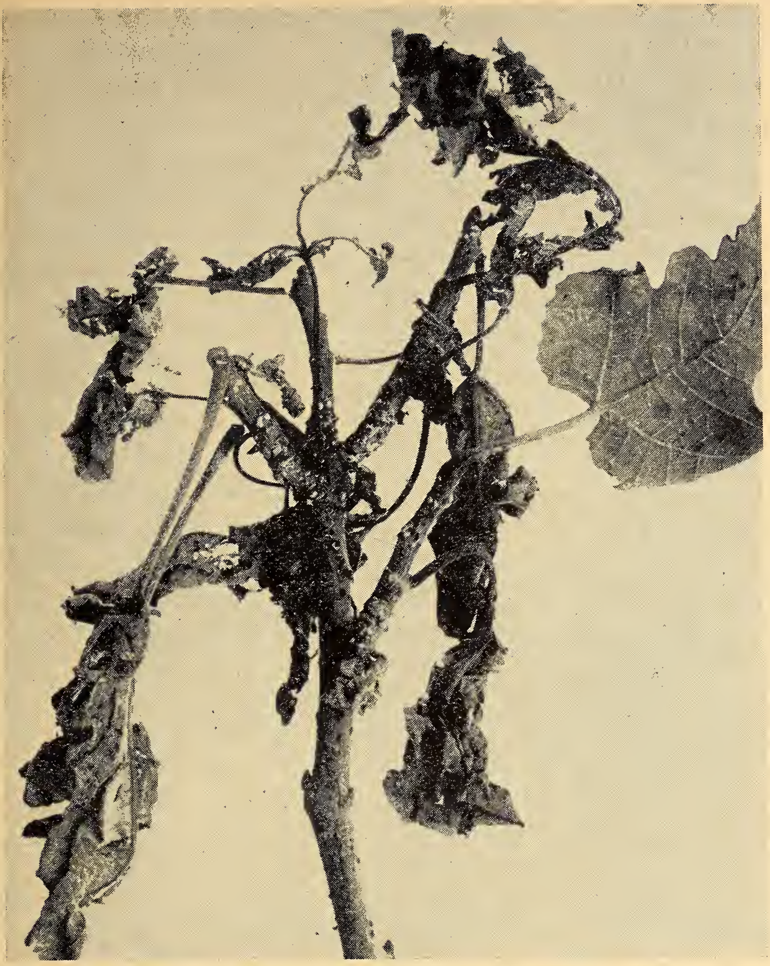

FIGURE 3. Fig branch affected by *C. stevensii,* showing sclerotia on twigs, dead leaves hanging on by hyphal threads, and basidial mat on lower surface of healthy leaf.

The possible role of basidiospores in the spread of leaf blight has also been studied. The evidence so far indicates that the spores are probably of little or no importance in dissemination of the leaf blight fungi. Careful observations have been made over a period of several years on this phase of the disease development. The thread blight fungus, *C. stevensii,* produces large numbers of basidiospores all during the summer, but practically no new infections develop on surrounding leaves that cannot be traced back to sclerotia on the twigs or to contact with diseased or dead leaves. Numerous inoculation tests were made with basidiospores from *C. stevensii* and the undetermined Corticium under conditions favorable for blight development, but in no case was the disease produced by such means.

VARIETAL REACTIONS

The Celeste is the predominant fig variety grown in the State. There are a few trees of some of the varieites with larger fruit, such as the Brunswick and Brown Turkey. No definite experimental data have been obtained on the resistance of the other varieties to leaf blights. However, where they are grown along with the common Celeste trees, no significant differences in amount of disease have been noted.

CULTURAL STUDIES ON THE LEAF BLIGHTING ORGANISMS

Representative cultures of the following leaf blight fungi were used in making the cultural studies: (1) *Corticium stevensii* from sclerotia on tung and fig twigs; (2) *C. microsclerotia* from fig leaf; and (3) *Corticium sp.* from a diseased fig leaf. For comparison with the latter fungus a culture of the *Corticium solani* type from an infected cauliflower stem was used. Each of the cultures used was considered typical of the species after considerable study in which large numbers of cultures were grown and compared. There was considerable variation in the growth characters of single basidial cultures of the undetermined Corticium. However, when cultures of *C. stevensii, C. microsclerotia,* and *Corticium sp.* were obtained from sclerotia or bits of diseased leaf tissue, they did not show such variation.

1. Temperature Relations.

Small, uniform pieces of agar from actively-growing plate cultures were transferred to petri dishes containing fresh string bean agar plates. The plates were incubated at 10, 15, 24, 28, 30, 32, and 36° C. The temperatures remained almost constant during the test period, the fluctuation being about one degree C. above or below the indicated temperature. The results of three different tests are summarized in table 1.

TABLE 1. TEMPERATURE RELATIONS OF THE FIVE FORMS STUDIED. GROWN ON STRING BEAN AGAR PLATES.

	AVERAGE DAILY INCREASE IN DIAMETER OF COLONIES IN MM. AT THE INDICATED TEMPERATURES						
	10° C.	15° C.	24° C.	28° C.	30° C.	32° C.	36° C.
C. stevensii..........	Trace	3.0	7.3	5.8	3.5	1.8	Trace
C. microsclerotia.....	0.0	9.0	36.0	40.0	25.0	20.0	Trace
C. solani............	Trace	10.0	38.0	45.0	40.0	35.0	3.0
Corticium sp........	3.0	10.0	30.0	35.0	22.0	15.0	Trace

Corticium stevensii grew much more slowly than the other forms. This fungus has always been a distinctly slow-growing form when compared with other species. In these tests, *C. solani* grew somewhat faster than the cultures from fig. All three of the faster-growing forms grew best at about 28° C.

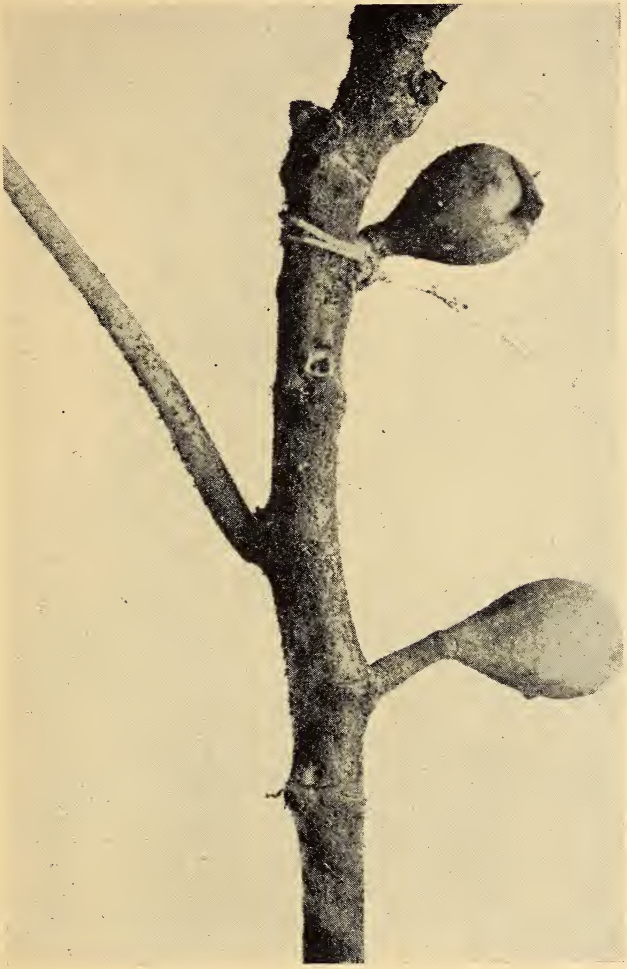

FIGURE 4. *Corticium microsclerotia* on fig branch. The small sclerotia appear on the twig, leaf petiole, and immature fig fruit.

2. Cultural Characters.

The four Corticiums were studied on a variety of solid media and several liquid media, but only a brief mention of these observations is included here. All the forms could be distinguished readily on most of the media. They grew well on string bean and potato dextrose agar slants. The characteristic feature of each form was the type and location of the sclerotia on the slant cultures.

Corticium stevensii produced small, loosely-formed sclerotia as the cultures aged. They appeared first as white, mycelial aggregations which slowly became more compact and turned light brown in color. The sclerotia never attained the size or compactness of those produced on twigs of the hosts. *Corticium microsclerotia* produced from one to several white sclerotia on the surface of the medium. The sclerotia were larger than those produced by the other forms and assumed a deep brown color with age. The undetermined Corticium from fig rarely produced definite sclerotia on the surface of the medium, but instead developed masses of small sclerotia on the sides of the tube just above the agar. These sclerotial masses were white when first formed and became dark brown as the cultures grew older. *Corticium solani* formed sclerotial masses on the sides of the tubes opposite from the medium.

The four Corticiums were grown at 28° C. on poured plates of five different agar media: fresh string bean, potato dextrose, prune, onion, and Czapek's. Only *C. microsclerotia* and *C. stevensii* produced definite sclerotia in these plate cultures. *Corticium solani* and the undetermined Corticium formed masses of sclerotium-like aggregations on the medium and on the sides of the petri dishes. These sclerotium-like masses were irregular in shape and more flattened than the sclerotia of *C. stevensii* and *C. microsclerotia.* All the forms grew well on the five media, although potato dextrose agar appeared to be more favorable than the others.

3. Inoculation Tests.

Numerous inoculations were made on fig leaves during the course of these studies. In the early tests some inoculations were made by fastening freshly infected leaves to the lower surface of healthy leaves with paper clips or small strips of paper tape. Infection took place readily when inoculations were made in this way. In general, the tests made under greenhouse conditions during the winter did not prove satisfactory, so most of the inoculations were made on trees growing outside.

A standard method of inoculation was developed after a number of different trials had been made. Inoculum from a pure culture of the fungus was spread over the lower surface of the fig leaves without wounding them. The inoculated leaves were wrapped in moist paper, a paper bag was put over the wet mass, pulled back and tied tightly around the branch on which the leaves were attached. In this way a satisfactory moist atmosphere was kept around the inoculated leaves. The paper bags and moist paper were removed after from 24 to 48 hours.

When favorable conditions prevailed, that is, relatively high summer temperatures and relative humidities, all the four forms were capable of killing fig leaves. The fast-growing forms, *C. solani, C. microsclerotia,* and the undetermined Corticium caused a rapid killing of fig leaves. If conditions were especially favorable, large full-grown leaves were completely destroyed within three days after inoculation. Under very humid conditions *C. microsclerotia* formed numerous small sclerotia on the affected leaves within a week after inoculation. No sclerotia were formed on the branches or leaves inoculated with *C. solani* or the *Corticium sp.* The latter form produced the basidial stage on the lower surface of some leaves, while in no case were basidia or spores formed on leaves inoculated with *C. microsclerotia.*

Corticium stevensii developed somewhat more slowly than the faster-growing Corticiums on fig leaves in most of the tests. But in one series of inoculations made with a number of single basidiospore cultures infection spread over the leaves rapidly, and within three days some leaves were completely killed. The basidial stage developed on uninjured portions of some leaves within a week after inoculation, and in many cases typical hyphal threads and sclerotia were produced on the twigs to which the inoculated leaves were still attached.

4. Basidiospore Studies.

During the early summer the basidial stages of *C. stevensii* and the undetermined fig Corticium are usually quite prevalent on the leaves of infected fig trees. The basidial mats are usually on the lower surfaces of the leaves. Such mats have only been observed on healthy leaf tissue. In the case of *C. stevensii* usually the entire lower surface of the leaves was covered by the basidial layer. The leaves affected by the fig *Corticium sp.* were often very ragged in appearance, the healthy portions covered with the basidial mat, the other parts having been killed by the fungus mycelium.

When such infected leaves were suspended within the covers of poured agar plates, within a few hours numerous spores usually fell to the surface of the agar. In this way it was an easy matter to obtain cultures of these Corticiums from germinating spores. By making spore dilutions in string bean agar and picking out single germinating spores, numbers of monosporous cultures of *C. stevensii* and the undetermined Corticium were obtained.

Measurements were made of the basidiospores of *C. stevensii* and the undetermined Corticium from fresh fig leaves. Isolations were made from the same material to confirm the identity of the fungi concerned. In all cases the cultures obtained from material identified as *C. stevensii* were typical of the cultures obtained from sclerotia of this fungus.

The average size and range in size of the basidiospores of *C. stevensii* and the undetermined Corticium are given in table 2. The measurements for each form are in close agreement. The spores of *C. stevensii* were longer and slightly narrower than those of the other Corticium. The average sizes of the two forms are apparently different enough to distinguish them as separate species.

TABLE 2. BASIDIOSPORE MEASUREMENTS OF *Corticium stevensii* AND *Corticium sp.* FROM FIG LEAVES. EACH LOT OF SPORES CAME FROM A DIFFERENT COLLECTION.

NAME OF FUNGUS	Number spores measured	BASIDIOSPORE MEASUREMENTS IN MICRONS		Check cultures from
		Average	Range	
Corticium sp............	60	4.5 by 7.7	3.4-6.3 by 6.3-9.0	a and b
Corticium sp............	100	5.0 by 8.4	3.4-6.6 by 6.3-10.0	c
Corticium sp............	48	5.5 by 8.7	3.4-6.3 by 6.6-10.4	b
Corticium sp............	100	4.9 by 7.5	3.1-6.3 by 6.3-10.1	c*
Corticium stevensii.......	100	4.6 by 10.8	3.1-6.3 by 7.5-13.6	a
Corticium stevensii.......	100	4.3 by 10.4	3.1-5.3 by 8.2-12.0	a and b
Corticium stevensii.......	100	4.8 by 10.8	3.1-6.3 by 8.9-12.6	c

a—single basidiospores.
b—mass basidiospores.
c—leaf tissue.

*Both *Corticium sp.* and *C. microsclerotia* were isolated from this material.

Studies previously reported (15) indicated that the thread blight fungus, *C. stevensii,* was probably homothallic. Numerous cultures obtained from sclerotia of this fungus from several different host plants have all been quite similar in cultural characters, as well as in pathogenicity on fig leaves. Single-basidiospore cultures obtained from fig leaves were also quite uniform in type and in all cases were similar to cultures obtained from sclerotia or from spore masses. When inoculated on fig leaves the monosporous cultures produced basidial mats with typical basidiospores and some days later hyphal threads and sclerotia developed on the young twigs near where the infected leaves were attached.

CONTROL MEASURES

The literature on control of fig leaf blight has not been very extensive. In 1918, Matz (8) recommended destroying infected leaves and twigs for control of *C. microsclerotia* in Florida. Taubenhaus (12) claimed that Bordeaux mixture gave good control (in one test) of the same fungus on fig trees in Texas. Bordeaux mixture was recommended by Weber (18) and Wolf and Bach (21) for the control of thread blight (*C. stevensii*) of pear, apple, and grapefruit. Control measures for thread blight were developed in 1940 (14, 20). Tims (14) demonstrated that one application of a copper sulphate-lime-arsenite mixture during the dormant season controlled the disease satisfactorily. This arsenite mixture was one of a large number of such mixtures which had been tested by Keitt (4) and his co-workers in Wisconsin for apple scab control. The use of Bordeaux mixture as a dormant spray for thread blight control as recommended by Weber (20) for Florida conditions was not effective in Louisiana.

The fig trees in this State are not planted in blocks as in most orchards, but are usually scattered around the house, garden, or farm buildings. They vary much in size and shape, and usually blight infection is not uniformly scattered over the different trees. A fig tree might be heavily infected with one of the Corticium leaf blights and the one next to it have little or none of the disease. For these reasons only selected trees known to be infected could be used in the spray tests.

The small numbers of infected trees available in one place and the variation in their size and shape made yield tests impracticable. Instead of using the yield tests as a measure of disease control, records were kept of the comparative numbers of early infections and of the estimated percentages of defoliation before the fruit was harvested. The latter gave a rough measure of the amount of loss suffered by the grower. The principal damage to the fruit was caused in two ways: (1) actual destruction of the figs by the leaf blight organisms, and (2) the exposure of the unripened figs to the direct rays of the sun and their failure to ripen as the result of the early death of the surrounding leaves.

We tested several of Keitt's arsenite mixtures on a small scale as dormant sprays for control of fig thread blight during the period 1935-38. Elgetol was also used at 1% strength for spraying the trees and for spraying the dead leaves beneath the trees. No control was obtained by the use of Elgetol, either when applied to the trees or to the soil around them. The mixture which gave practically complete control of thread blight (called "arsenite mixture A") contained copper sulphate 1½%, lime 1%, zinc arsenite 1%, monocalcium arsenite ¼%, and fish oil 1% (the percentages being by weight, except the fish oil, which was measured by volume). The amounts of chemicals necessary to make up 10 gallons of the mixture are:

21 oz. copper sulphate
14 oz. lime
14 oz. zinc arsenite
3½ oz. monocalcium arsenite
14 oz. fish oil.

A single application of this spray mixture applied in December or January gave good control of thread blight.

The later spray tests (1939-42) were complicated by the presence of *C. microsclerotia* and the undetermined Corticium on the fig trees. The excessive rainfall in June and July during the past three years (1940-42) also made the leaf-blight much more severe than in normal years. The arsenite mixture kept the blight under control fairly well until most of the fruit was harvested—about July 25—but later in the summer there was considerable defoliation of the sprayed trees, principally by *C. microsclerotia* and the *Corticium sp.*

The results of the spray test at Union in 1939 are given in table 3. The trees were not in a compact group but were arranged roughly in one row. Tree No. 5 was somewhat isolated from the others, but most of the remaining trees were in contact with each other or at most only a few feet apart. The spray mixture gave almost complete control of the blights until the fruit was harvested, while the unsprayed trees were badly diseased. Typical branches from sprayed and unsprayed trees are shown in Fig. 5. Later in the summer there was considerable defoliation of trees No. 6 and No. 14 on which *Corticium sp.* and *C. microsclerotia* were most prevalent.

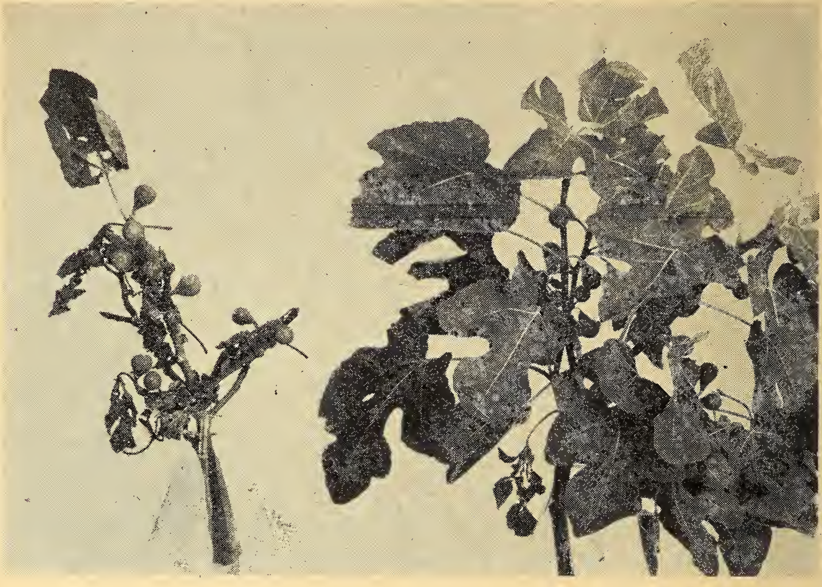

FIGURE 5. Fig branches showing effect of spraying for blight control. Unsprayed branch on left and sprayed on right.

TABLE 3. RESULTS OF SPRAY TEST AT UNION IN 1939. ONE APPLICATION OF ARSENITE MIXTURE A MADE JANUARY 18. OBSERVATIONS MADE JULY 7, WHEN FIRST FRUIT WAS BEGINNING TO RIPEN.

Tree No.	TYPE OF BLIGHT	Treatment	Estimated amount of defoliation
1, 2, 3, 4	*Corticium stevensii*	Sprayed 1939	Trace*
5	*Corticium stevensii*	Sprayed 1938‡	Trace*
6	*Corticium sp.* and *C. microsclerotia*	Unsprayed	65%
7	*Corticium sp.* and *C. microsclerotia*	Sprayed 1939	2%†
8	*Corticium sp.* and *C. microsclerotia*	Unsprayed	60%
9	*Corticium sp.* and *C. microsclerotia*	Unsprayed	25%
10	*Corticium sp.* and *C. microsclerotia*	Sprayed 1939	3%†
11	*Corticium sp.* and *C. microsclerotia*	Unsprayed	40%
12	*Corticium sp.* and *C. microsclerotia*	Unsprayed	20%
13	*Corticium sp.* and *C. microsclerotia*	Unsprayed	20%
14	*Corticium sp.* and *C. microsclerotia*	Unsprayed	25%

*Very little subsequent spread of blight on these trees.

†The trees were affected more severely later in the season.

‡One application of "arsenite mixture A" in 1938. None in 1939.

In the 1941 and 1942 tests there was some (as high as 10%) early defoliation on the trees that were sprayed in the winter with arsenite mixture A. This was the result of continued excessive rains over a period of four to five weeks before time for the fruit to ripen. Measures were taken to reduce this early defoliation. One application of Bordeaux mixture (4-4-50) applied about June 1 kept the disease under control until after the fruit was harvested. These results indicate that the one application of arsenite mixture A, during the winter when the trees are dormant, is sufficient to control Corticium blights under normal conditions. If excessive rains should come in late May and extend through June and if blight begins to show up on the sprayed trees, one application of Bordeaux mixture may be necessary to keep the trees in good condition.

PRACTICAL CONTROL IN A SINGLE ORCHARD

A group of seven large fig trees, six of them Celeste, the other variety unknown, at Farm A, was selected in 1938 for a test on practical application of control measures. Two of the trees were severely affected by *C. stevensii,* and all the others had some of the disease. The owner, who received considerable revenue from these trees, by canning the fruit and selling it at a good price to selected customers, had decided to destroy them because of their diseased condition. In the 1938 and 1939 seasons one application of arsenite mixture A was applied in January to all the trees. There was only an occasional blight infection on the two severely diseased trees before the figs were harvested, and none on the others. Excellent crops of figs were obtained both years. There was some severe freeze injury during the winter of 1939-40 and the fig crop was greatly reduced on most of the trees.

In 1940 *C. microsclerotia* appeared on some of the trees but caused little trouble. This fungus later spread to all the trees used in this test, but it has never caused much damage as long as the spray schedule has been kept up. The thread blight fungus (*C. stevensii*) has persisted on these trees throughout the five-year period that the experiment has been continued. But during the past two seasons, 1941-1942, there have been only scattered infections on the trees. Beginning in 1941 the dormant spray was not applied for two seasons. Instead of spraying the entire trees, Bordeaux mixture was applied on the portions of the trees where early infections began. When the leaves were covered with Bordeaux mixture for a distance of about two feet on all sides of the infection center, little further spread took place. The trees were examined twice during June and all infection centers were thoroughly covered with Bordeaux mixture. By this method the fig trees at Farm A were kept free of serious blight damage for two years, with comparatively little trouble or expense.

SUMMARY OF CONTROL MEASURES

The kind of control measure to be used depends upon (1) the type of blight, i.e., whether caused by *C. stevensii* (as evidenced by the presence of brown sclerotia and hyphal threads) or by either of the other fungi (*C.*

microsclerotia or *Corticium sp.*) and (2) the severity of the disease. *C. stevensii* can be successfully controlled by one application of arsenite mixture A in December or January. The other types of blight can usually be controlled by the same spray mixture. But in wet seasons an application of Bordeaux mixture 4-4-50 in early June may be necessary. Spraying is not advised unless the trees are known to have blight. If the infection is light, as evidenced by small clumps of dead leaves or twigs devoid of leaves scattered over the trees in late May or early June, the dead areas and healthy leaves around them should be sprayed with Bordeaux mixture. This prevents the blight from spreading to other parts of the trees.

It is a good practice to remove the dead branches from the fig trees. Cutting out the small infected branches and destroying them after leaf-blight begins in the summer may be helpful in keeping the disease under control.

SUMMARY

1. Corticium leaf blights cause serious damage to fig trees in Louisiana. Three apparently different fungi cause leaf-blighting here. They are *Corticium stevensii, Corticium microsclerotia,* and an undetermined Corticium.

2. The three fungi produce leaf symptoms which are quite similar in most respects. However, *C. stevensii* produces distinctive brown sclerotia and hyphal threads; *C. microsclerotia* develops large numbers of very small sclerotia; and the undetermined Corticium has no definite sclerotial stage connected with it.

3. Leaf-blights begin to develop here in May or early June and may persist until fall.

4. The three causal fungi were studied in culture on a number of media and compared with *C. solani*. *Corticium stevensii* is a slow-growing form with an optimum temperature around 24° C., while *C. microsclerotia* and *Corticium sp.* are fast-growing forms with an optimum about 28° C. *Corticium stevensii* is apparently a homothallic form.

5. The undetermined Corticium is similar in many respects to *C. solani.*

6. Inoculation tests showed that the three blight fungi are capable of causing a rapid killing of fig leaves when conditions are favorable. The faster-growing forms usually killed fig leaves more rapidly than the slower-growing *C. stevensii.* The latter fungus produced typical hyphal threads and sclerotia on the inoculated twigs and basidial mats on some inoculated leaves. *Corticium microsclerotia* produced numerous sclerotia when moisture was abundant, but no basidial mats were formed. The *Corticium sp.* developed basidial mats on certain leaves, but no sclerotia were formed.

7. Basidiospore measurements showed that the spores of *Corticium stevensii* were distinctly different from those of the Corticium sp.

8. *Control Measures.* A single application of a copper sulphate-lime arsenite mixture made during December or January effectively controlled Corticium leaf blight caused by *C. stevensii.* On trees infected with *C. microsclerotia* and *Corticium sp.* the arsenite mixture gave good control except in excessively wet seasons, at which times one application of Bordeaux mixture 4-4-50 applied early in June following the dormant spray gave satisfactory control.

9. The spraying of fig trees as a preventive measure, in the absence of any blight symptoms, is not advised.

10. If infection is light the leaf blights may be effectively controlled by applying Bordeaux mixture around the infected areas soon after symptoms appear.

11. Pruning out and destroying scattered branches known to be infected with the leaf blight fungi will reduce the amount of disease.

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LOUISIANA BULLETIN NO. 368 JULY, 1943

RICE AND RICE BYPRODUCTS FOR FATTENING SWINE

By

CHAS. I. BRAY

RICE BYPRODUCTS AND CORN MAKE MORE
RAPID GAINS THAN CORN ALONE

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICUTURAL EXPERIMENT STATIONS

W. G. TAGGART, *Director*

GENERAL SUMMARY

1. In 1943 with feeds at high prices and difficult to obtain, it is important that in fattening hogs (1) all possible use be made of pastures and various waste feeds on the farm; (2) that feed crops such as sweet potatoes, corn, and peanuts be planted for hogging off; (3) that good protein supplements be fed; and (4) that feed stuffs be combined in the best proportions so that gains will be put on for the least feed. While these experiments have to do largely with dry-lot feeding, it has been for the purpose of working out the best combinations of feeds to produce the most economical gains.
2. *Rice bran* is a low priced, medium protein feed, low in lime but high in phosphorus. Rice bran gives good results in combination with corn for hog feeding. When fed as the main concentrate and balanced by protein supplements, rice bran has a value of 85%-87% the feeding value of corn. But when combined with corn in the ratio of 2 parts of corn to 1 part of rice bran, more rapid gains are produced than on corn alone and the rice bran may replace from 100% to 115% its weight of other feeds. Rice bran fed in large amounts to fattening hogs produces soft pork but in the proportions given above, produces pork of satisfactory firmness.
3. *Rice polish* is a rich and highly digestible concentrate feed, low in fiber, containing more digestible nutrients than corn, also more protein and four times as much phosphorus. Rice polish has about 25% higher value than rice bran and 12½ to 15% higher value than corn. When combined with corn in the proportion of 2 parts corn to 1 part rice polish it approximately replaces 121% its weight in corn if fed with the proper protein supplements. Rice polish also produces soft pork if fed in excessive amounts.
4. *Brewers rice* and rice screenings are equal to, or slightly superior to corn in feeding value and produce a high quality of firm pork. Ninety-four to 95 pounds of brewers rice will usually replace 100 pounds of corn, and will produce a firmer carcass.
5. *Rough rice* may be used satisfactorily for fattening hogs and in these tests has shown an estimated value of from 88 to 91% the value of corn when well ground and properly supplemented with protein and minerals. The rough rice should be ground sufficiently so that the hulls are reduced to a fine meal. Where the hulls are left whole they are unpalatable to hogs. Damaged rough rice should sell at least 12% lower than corn to be profitable for feeding.
6. *Soybean oil* meal is one of the best vegetable protein supplements for balancing hog rations. Cottonseed meal may be used as a protein supplement in larger amounts than was formerly thought safe if treated with 1% of ferrous sulphate, which prevents gossypol poisoning (cottonseed meal poisoning). Recent experiments indicate that peanut oil meal is superior to soybean oil meal. In these times when there is a scarcity of animal protein such as tankage, shrimp meal, etc., it is advisable to use about 20% animal protein, as tankage or shrimp meal, to 80% of soybean oil meal, peanut meal, or cottonseed meal in making up protein supplements.

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RICE AND RICE BYPRODUCTS FOR FATTENING SWINE

With Comparisons of Pastures and Protein Supplements

by

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Rice is one of the most important cash crops in Louisiana, ranking next to cotton, sugarcane, and corn in total income. Louisiana produced in 1942, 7,155,000 barrels of rice (25,758,000 bushels) or a little less than 39 per cent of the total rice grown in the United States. If allowance is made for a certain percentage held back for seed and feed, this amount produces annually about 73,000 tons of rice byproducts available in Louisiana. In addition to this, some damaged rough rice may be used as feed. When these rice byproducts are used in proper feed combinations, they give excellent results.

TABLE I. PRODUCTION OF RICE IN THE UNITED STATES AND LOUISIANA IN 1942, WITH ESTIMATED PERCENTAGE OF MILL BYPRODUCTS.

		United States	Louisiana
Rice production—bushels	....	66,333,000	25,758,000
barrels	....	18,426,000	7,155,000
ESTIMATED BYPRODUCTS	Per Cent	Tons	Tons
Rice bran	8.64	100,000	38,630
Rice polish	1.85	21,310	8,278
Brewers rice	2.10	24,142	9,379
Rice screenings	3.10	35,650	13,950
Total other than rough rice	....	181,102	70,237
Chicken feed rice	0.5	7,100	2,759
TOTAL	....	188,202	72,996

OFFICIAL DEFINITIONS OF RICE BYPRODUCTS AS ADOPTED BY AMERICAN FEED CONTROL OFFICIALS*

Rice Bran is the pericarp or bran layer of the rice, with only such quantity of hull fragments as is unavoidable in the regular milling of rice.

Rice Polish is a byproduct of rice obtained in the milling operation of brushing the grain to polish the kernel.

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* Report of Analyses of Commercial Feed Stuffs. Season of 1939-40. Louisiana Department of Agriculture and Immigration.

Rice Meal is ground brown rice or ground rice after the hull has been removed.

Ground Rough Rice is ground rice from which the hull has not been removed, or ground paddy rice.

Rice Stone Bran is the siftings from the materials secured in removing hulls from rice and contains rice germs, broken rice and some rice hulls.

Rice Huller Bran is a product secured by the huller and comes from brown rice and consists mostly of the bran and germs.

FEED NUTRIENTS AND MINERALS IN RICE FEEDS

The following table, adapted from Morrison's *Feeds and Feeding,* 20th edition, shows the digestible nutrients and the calculated feeding value of rice products compared with corn and other common feedstuffs. (22)

TABLE II. Percentage of Protein, Total Nutrients, Fiber and Calcium and Phosphorus in Rice Feeds Compared to Other Common Feeds.

	Per Cent dry matter	Per Cent digestible protein	Per Cent Fiber	Per Cent digestible nutrients	Mineral elements	
					Calcium	Phosphorus
Rice polish	90.5	9.3	3.0	85.7	0.04	1.10
No. 1 corn	87.2	7.3	2.3	83.5	0.01	0.28
No. 3 corn	83.5	7.0	2.2	79.0	0.01	0.27
Brewers rice	88.0	5.4	0.8	79.7	0.04	0.10
Wheat shorts	90.1	15.1	6.2	76.3	0.09	0.72
Wheat bran	90.6	13.1	9.5	70.2	0.12	1.32
Rice bran	91.1	8.8	13.0	67.7	0.08	1.36
Rice bran, low grade	90.1	5.3	20.2	45.2	....	....
Rough rice	88.6	6.3	8.8	69.1	....	0.21

The Process of Milling

The work of the rice miller is to remove the hulls, germs, and outer seed coatings of the rice grain in such a way as to leave a high percentage of whole grains or head rice with a low percentage of broken grains, such as second heads, screenings, and brewers rice.

The rough rice is first put through a cleaning process to remove dirt, trash, long beards, stems, and light or blighted grains, and goes next to the hulling stones which crack or split the hulls. The mixture of partially hulled rice and hulls is then put through a revolving screen called the "stone reel" or a shaker called a "rotex," which separates out all fine particles of hulls, rice germs and true bran. This material is called "stone bran" which has a much larger percentage of fiber than huller bran. The loose hulls are removed by aspiration or screening and used as fuel. Any remaining unhulled grains are separated out by the paddy separator and passed through another set of huller stones to complete the hulling process. (23) (37)

The hulled brown rice goes next through the machines, incorrectly called "hullers," which remove the bran. There are seven bran layers around the rice grain and the hullers remove six of these and some of the seventh. This bran is "huller" bran, the bran with which we are most familiar, and this is removed by the first-break and second-break bran reels, or the rotex machine. In a few mills the hulled rice may next be put through a "pearling cone" where a finer bran or polish product is removed, known as pearling cone polish or cone meal.

This meal is sometimes sold separately, for feed and sometimes for extracting vitamins for medicinal purposes, while some mills mix this product with the huller bran and others mix it with the polish from the brushes. The rice grains next go through the "brush" or polishing machine which removes the rest of the seventh coat or aleurone layer, together with some starch cells, producing a fine cream-colored floury material known as rice polish or polishings, the color depending upon the quality of the rice. This product contains very little fiber but more nutritive material than any other rice byproduct. The polished rice then goes to the brewers reel which takes out the small rice particles, averaging less than one-quarter grain, known as brewers rice. The whole grains and larger broken parts then go through the grading machines and are separated into head rice, second heads and rice screenings. Any weed seeds not previously removed can be partly removed by passing over a gravity machine. Increased efficiency in the milling process in the past few years has greatly reduced the percentage of broken grains, and modern seed machines remove more of the seeds than was formerly the case.

DISCUSSION OF RICE FEEDS

Rice Bran

Rice bran is the principal byproduct of the rice milling industry. It is a low priced feed, medium in protein content, high in fat, and high in phosphorus but low in calcium. Rice bran contains about 84% as much calculated digestible nutrients as No. 2 corn, but shows a higher value than this when fed in suitable feed mixtures.

While rice bran is only moderately high in protein, the proteins are of good quality and are better balanced than the proteins of corn. Kik, of the Arkansas Station, (18) reports that rice bran proteins compare favorably with the proteins of milk. The proteins of rice bran appear to supplement the proteins of corn in such a way that when corn and rice bran are fed together, the two proteins combined are more efficiently utilized than where either is fed alone. (21)

Rice bran has a higher fat content than wheat bran, and the fat is somewhat oily. This high percentage of oil is mainly responsible for the production of soft pork where rice bran or rice polish are fed in excessive amounts to fattening hogs. It is also the reason why rice bran may become rancid in hot weather. In some mills rice bran and polish are kiln dried to destroy the enzymes which produce rancidity. In the better class mills the rice is thoroughly dried before milling, which is believed to produce not only better rice but better bran and polish.

Since rice bran, like corn, is low in calcium (lime), animals on rations containing much rice bran or corn should have access to a mineral supplement containing fine ground oyster shell or ground lime stone. In one feeding test where rice products were fed, a mineral mixture of ground oyster shell and salt seemed to give as good results as one containing bone meal in addition. (Page 35).

Low-grade rice bran usually contains a large amount of hulls, the percentage of fiber indicating the proportion of hulls. According to Fraps, (12) rice bran with 8% fiber contains little or no hulls, 10% fiber indicates about 6.4% hulls, and 15% fiber indicates over 20% hulls. Rice bran in Louisiana should not show more than 12% fiber. The better grades of bran average 9% fiber. Some small mills produce a low-grade bran containing 50% or 60% of hulls which makes it undesirable for feeding. The practice of mixing hulls with rice bran has done much to hinder the sale of rice products. In buying rice bran it is advisable to buy only bran that has been inspected and tagged giving a guaranteed analysis.

RICE BRAN COMPARED TO CORN

Rice bran has been compared to corn in a number of experiments. An average of ten tests where both feeds were properly supplemented show that rice bran has about 87% to 88% the value of corn when fed as the main concentrate to fattening hogs.

TABLE III. Rice Bran Compared to Corn for Fattening Hogs
(Based on gains, and on feed per 100 pounds gain.)
10 Experiments*

Ration	Daily Gain lbs.	Feed per 100 pounds gain		
		Corn or Bran	Protein	Total
Corn	1.32	397.6	36.8	434.4
Rice Bran	1.10	449.5	39.3	488.8

*Tables III to VIII. are based principally on experiments conducted by the Arkansas, California, Texas and Louisiana Experiment Stations and by the Iberia Experiment Station at Jeanerette, Louisiana.

Eighty-eight pounds of corn replaced 100 pounds of rice bran, and the pigs on rice bran made 83% as rapid gains as those on corn.

COMBINATIONS OF CORN AND RICE BRAN ARE MORE EFFICIENT

Where corn and rice bran are combined in a proportion of 2 to 1, with protein supplements, the rice bran rations produced higher gains and required less feed per unit of gain.

TABLE IV. CORN COMPARED TO CORN AND RICE BRAN FOR FATTENING HOGS
(Based on gains, and on feed per 100 pounds gain.)
4 Experiments

	Daily Gain	FEED PER 100 POUNDS GAIN			
		Corn	Rice Bran	Protein	Total
Corn	1.37	383.6	.....	44.2	427.8
Corn and Rice Bran	1.45	260.5	110.0	40.2	410.5

One hundred and ten pounds of rice bran replaced 123.3 pounds of corn and 4.2 pounds of protein. Rice bran fed in amounts equal to one third of the ration apparently replaced 115% of its weight of other feeds, and increased the rate of gain about 5 percent. Rice bran is therefore more valuable to the hog feeder when fed with corn or similar feeds than when fed alone.

Robison, Ohio, (27) has reported extremely high values for small amounts of rice bran or rice polish added to corn and linseed meal rations. Tests at this station with small amounts of rice bran have not shown such high values, possibly because more complete protein mixtures were used in the Louisiana tests.

RICE BRAN COMPARED TO RICE POLISH

A considerable number of comparisons have been made of rice bran and rice polish. Thirteen of these tests have been averaged in the following table:

TABLE V. RICE BRAN COMPARED TO RICE POLISH
(Based on gains, and on feed per 100 pounds gain.)
(13 Comparisons)

	Average Daily Gain	FEED PER 100 POUNDS GAIN		
		Rice Byproduct	Protein	Total
Rice Bran	1.02	437.6	55.0	492.6
Rice Polish	1.26	332.1	40.9	373.0
Difference		105.5	14.1	119.6

332.1 pounds polish replaced 437.6 pounds rice bran and 14.1 pounds protein, or, 100 pounds polish replaced 136.0 pounds bran and protein.

However, when bran and polish are fed in combination with corn there is not as much difference in value between them. In eight comparisons in Louisiana, California, and Texas, rice bran and rice polish were fed in combination with corn or barley. The summary of these eight tests is as follows:

TABLE VI. RICE BRAN AND RICE POLISH COMPARED WHEN FED IN COMBINATION WITH CORN OR BARLEY
(8 Comparisons)

	Daily Gain	FEED PER 100 POUNDS GAIN			
		Corn or Barley	Rice Bran or Polish	Protein	Total
Rice Bran Mixtures	1.66	237.2	153.4	29.4	420
Rice Polish Mixtures	1.68	212.5	151.6	25.9	390
Difference		24.7	1.8	3.5	30

There was very little difference in daily gains and only 30 pounds of difference in total feed required per 100 pounds gain. About 100 pounds of rice polish replaced 101.2 pounds of rice bran, 16.3 pounds of corn, and 2.3 pounds protein mixture. Rice polish was 19.8% more efficient than rice bran in these combinations.

RICE BRAN COMPARED TO WHEAT SHORTS

In one experiment, 1933, two lots fed corn and rice bran were compared to two lots fed corn and wheat shorts. The rice bran appeared to be equal to shorts in one comparison and a little less valuable in the other, the average value being about 96% that of shorts when fed in properly balanced rations (Page 23). Upp (30) found the two to be practically equal for poultry.

References on Rice Bran:

Burns (3) of Texas reported one experiment where rice bran alone made better gains than corn alone but a mixture of rice bran and corn was superior to either one alone. Burk (5) of Texas reported that pigs made 37% faster gains with rice bran mixed with milo than when no milo was fed. Hogs killed firm on a ration of half milo and half rice bran with cottonseed meal as the protein supplement. Cobb (6) Iberia Station, concluded that rice bran was about 84.7% as efficient as corn for fattening hogs when proper protein supplements were used. In some of his experiments rice bran made more economical gains than corn. Aguanta (1) of the Philippines reported rice bran to be 3.3% more efficient than corn bran for supplementing corn and copra meal. Williams, Texas, (35 and 36) reported rice bran to have only 57.2% the value of corn when fed alone and recommended feeding with equal parts of corn. Tirol (38), Rivera (25), Valdez (31) in the Philippines reported unsatisfactory returns from coarse rice bran containing 60% hulls when feeding smaller pigs but used a mixture of half fine rice bran and half coarse bran for feeding larger hogs. They estimated that the ground hulls had apparently some feeding value for older pigs. The coarse rice bran had only 38% the feeding value of standard bran.

RICE POLISH

Rice polish is a concentrated and highly digestible feed of very fine texture, quite palatable to most livestock. It is low in fiber and contains more protein and fat than corn, a higher total of digestible nutrients and has four times as much phosphorus. The proteins of rice polish are a little better balanced than the proteins of corn, which partially explains why rice polish fed alone shows a higher value than corn fed alone. Because it is so highly concentrated, and so fine in texture it is more suitable for feeding in mixtures than for feeding alone.

VALUE OF RICE POLISH COMPARED TO OTHER FEEDS

Early experimenters, (10) comparing rice polish alone to corn alone for fattening hogs, obtained values for rice polish 25% better than corn, the reason being that rice polish is a more complete feed than corn. But in later tests when tankage and other high protein feeds were used, and better rations were fed, the relative value of polish has been about 12½% to 15% better than corn. An average of eight experiments at southern stations shows that where rice polish and corn were both fed with appropriate protein supplements, the daily gains were practically the same, but the hogs getting rice polish required 12% less feed per 100 pounds gain.

TABLE VII. Corn vs. Rice Polish With Supplement
(8 Comparisons)

	Daily Gain	Feed per 100 pounds gain			
		Corn	Rice Polish	Protein	Total
Corn Ration	1.51	366.1	.....	34.3	400.4
Rice Polish Ration	1.51.6	.....	323.1	33.3	356.4
Difference		.....	43.0	1.0	44.0

On this basis, about 88 pounds rice polish replaced 100 pounds corn and protein.

Another group of eight experiments comparing corn with corn and rice polish show higher values for the rice polish.

TABLE VIII. Corn Compared to Corn and Rice Polish: Both Supplemented With Protein
(Average of 8 Comparisons)

	Daily Gain	Feed per 100 pounds gain			
		Corn	Rice Polish	Protein	Total
Corn Ration	1.49	352.1	.....	34.1	386.2
Corn and Rice Polish Ration	1.53	215.3	110.6	31.5	357.4
Difference		136.8	.....	2.6	28.8

In these tests, 110.6 pounds rice polish replaced 139.3 pounds corn and protein or 79.4 pounds rice polish replaced 100 pounds corn and protein.

This shows that where rice polish is fed as the principal fattening feed, with a protein supplement, it has a value approximately 112% that of corn, and where fed in combination with corn and protein, it may replace 121% its weight of corn and other feeds. It is preferable to feed rice polish with other feeds such as corn, rather than alone.

RICE POLISH AND RICE BRAN FOR FEEDING BROOD SOWS

Rice polish and rice bran may be used in much larger amounts for brood sows, boars, or other stock hogs than for fattening hogs. At the Iberia station, rations of two parts rice polish and one part corn; or two parts rice bran and one part corn were fed satisfactorily to brood sows, used with appropriate protein and mineral mixtures.

At the Arkansas station (20) sow pigs were taken at weaning age and developed on a mixture of rice polish 60 parts, rice bran 30 parts, and tankage 10 parts by weight. These sows were carried on this ration until three weeks after weaning without any unfavorable results. Such feeding does not affect the hardness of fat of the pigs from these sows.

Since in Louisiana, rice polish is usually cheaper than corn, it is economical to use in feeding stock hogs. Rice polish is not desirable for feeding in large amounts to small pigs as it is likely to produce scouring and general unthriftiness. Martin at the Arkansas station (20) found that rye pasture increased the tendency of rice bran and rice polish to produce scouring with small pigs. After pigs reach a weight of about 75 pounds they are not so likely to scour when fed polish.

Rice polish, like rice bran, should be supplemented by high protein feeds and by mineral mixtures, particularly those containing lime; and is much more desirable as a supplement to corn than when fed as the main concentrate.

RICE PRODUCTS AND SOFT PORK

Because of the soft oils in rice bran and rice polish, the carcasses of hogs fed entirely on these feeds up to time of slaughter will be too soft. For this reason, large amounts of these feeds should not be fed within 8 weeks of marketing. Two methods of feeding rice bran or rice polish may be followed. One is to feed such feeds only during the early part of the fattening period, and then change to hardening feeds like corn, barley, brewers rice or rice screenings at least 6 or 8 weeks before slaughter. The other method is to feed not over 30% of rice bran or polish during the entire feeding period. Cobb, Iberia, reported that hogs fed brewers rice for eight weeks after they had been on softening feeds always killed hard, while with corn fed eight weeks, a few of the hogs killed were medium hard and some medium soft. Cobb also reported that when hogs were given free choice of feeds they chose more of the hardening feeds toward the end of the fattening period.

RICE SCREENINGS AND BREWERS RICE

Rice screenings and brewers rice consist of parts of milled rice grains broken during the process of milling and polishing. A barrel of 163 pounds of rice may produce approximately 26 pounds of broken rice, divided according to size into about 9 pounds second-head milled rice, 12 pounds screenings-milled rice, and 5 pounds brewers rice. These classes are subgraded as extra fancy, fancy, extra choice, choice, and medium, depending on the percentage of weed seeds, grains of other cereals, and chalky kernels contained. The second head rice and high grade screenings are used for human consumption or for the manufacture of rice flour and rice paste. Brewers rice, consisting of the smallest particles of broken rice, is so named because it is used largely in the manufacture of beer. During prohibition it was used largely for feeding livestock. The lower grades of screenings are used principally for stock feed. Screenings and brewers rice are more or less of equal value for feeding, the difference in size of grain being of no particular importance. During the present war emergency all grades of rice which can be used for human food are in demand for that purpose.

Brewers rice is one of the best feeds for fattening swine. It has shown a feeding value at least equal to corn or slightly better for swine. Brewers rice produces a hard white fat and is especially valuable for hardening the fat of hogs that have been on softening feeds such as mast, peanuts, or rice bran. When the price of brewers rice is at or below the level of corn prices, it should be used for feeding.

An average of twenty-two experimental tests comparing brewers rice and corn for fattening hogs showed brewers rice to be about 5.85% better than corn when both were fed in properly balanced rations. Hogs on brewers rice rations ate approximately 16.4% less protein than the corn hogs, indicating that the proteins of brewers rice are of higher value than the corn proteins.

TABLE IX. Brewers Rice Compared to Corn for Fattening Swine
(Feed required per 100 pounds gain)
22 Comparisons*

	Basal Feed	Protein Supplement	Total Feed per 100# Gain
	lbs.	lbs.	lbs.
Corn	387.0	26.9	413.9
Brewers rice	367.2	22.5	389.7
Difference, lbs.	19.8	4.4	24.2
Difference, per cent, in favor of brewers rice	5.2%	16.4%	5.85%

*Cobb, Iberia Sta., 11 tests; Martin, Arkansas Sta. 9 tests; Bray, Louisiana Sta., 2 tests.

In two tests with rice screenings, 1938-1939, rice screenings fed with equal parts of corn were more economical than corn alone, both lots receiving proper protein and mineral supplements and some oat pasture. The rice screenings produced a firmer grade of pork. (See page 40.) In both of these tests the hogs receiving rice screenings ate less feed and made slightly lower gains than those on corn but the gains were put on for less feed.

Cobb (6) Iberia station, La.,, estimated that 94 pounds of brewers rice was equal to 100 pounds of corn and was superior to corn in producing firm pigs. A ration of 47% brewers rice, and 47% rice polish with 5.6% tankage produced gains for less feed than with rice polish and tankage. Hughes (15) California, reported that pigs fed brewers rice required 95 pounds less carbonaceous concentrates and 6.5 pounds less tankage per 100 pounds gain than for hogs fed rolled barley and tankage. Barley had about 88% the value of brewers rice for fattening hogs. Martin (20) Arkansas, reports that brewers rice and tankage was superior to corn and tankage, and produced firmer carcasses than corn.

ROUGH RICE

During some seasons a certain amount of rice is damaged by rain so that it brings a relatively low price compared to high grade rice. This damaged rice is frequently used in the rice area for feeding farm stock such as dairy cattle, mules or hogs and poultry. Hogs are sometimes turned into rice fields after harvest to pick up scattered rice left in the field. Some rice has a low grade on account of containing red rice which lowers the market value but probably does not greatly affect feeding value. When there is a strong demand for rice, low grade rice does not usually sell at a low enough price to be profitable to the feeder. Rice should be finely ground for feeding hogs so that the hulls are made into a fine meal.

An average of three comparisons at the Louisiana station, 1938-39-40, showed the following results: (See pages 36-43.)

TABLE X. COMPARATIVE VALUES OF CORN AND GROUND ROUGH RICE

RATION	Daily Gain	FEED PER 100 POUNDS GAIN			
		Grain	Protein	Mineral	Total
1. Corn 90, protein 9, mineral .1	1.91	357.5	35.7	3.9	397.4
2. Ground rough rice 90, protein 9, mineral 1	1.79	391.5	39.1	4.3	435.0
3. Corn 45, ground rough rice 45, protein 9, mineral 1	1.80	376.6	37.7	4.1	418.5

These results show a 91.3% value for the second ration with rough rice as the only grain and a 94.8% value for the third ration using equal parts of rice and corn, counting the corn ration as 100%. Calculated on the basis of replacement values for rough rice; the rough rice showed an apparent value of 91% the value of corn in Lot 2 and 88% in Lot 3. However, in one of the three experiments the corn lot (Lot 1) made lower gains than usual (page 39) which probably gave the rough rice fed in Lots 2 and 3 a value which is too high. The true value for well ground rough rice is probably not over 88%-90% the value of corn.

Hogs will not do as well on rough rice which is coarsely ground. On one occasion when the wrong screen was used in grinding the rough rice, and the hulls were left whole, the pigs failed to gain and refused much of their feed.

No objectionable results have been found that could be attributed to the ground hulls in fine ground rough rice. In coarsely ground rice there might be some irritation of the digestive tract. The principal objection would seem to be the unpalatability of the loose hulls in coarse ground rice. There may be some feeding value in fine ground hulls.

References on Rough Rice:

Cruse (9) of Texas reported ground rough rice to be equal to or slightly superior to corn when fed with alfalfa meal but inferior to corn when fed with cottonseed meal. He found ground rough red rice an economical ration for pigs when balanced with cottonseed meal or alfalfa meal. Weaver & Moffett (33) of Missouri estimated rough rice to be 18% less valuable than corn when used as the only grain feed and 10% less valuable when mixed with equal parts of corn. Cooking whole rice was less satisfactory than grinding. Whitehouse & Bostock (34) New South Wales, reported rough rice to be 88% the value of wheat. Hughes (14) California, found that cooking whole rice was unsatisfactory and finely ground rough rice was much more satisfactory than coarse ground. Ground rough rice was slightly less valuable than ground barley. Pigs ate less rough rice than barley but ate nearly 30 pounds more tankage per 100 pounds gain. Pigs on fine ground damaged rice gained 32% faster than on coarse ground rough rice. Jordan & Kidder (17) Louisiana, found that hogs made lower gains with ground rough rice and tankage than with corn and tankage but made higher gains on a mixture of ground rough rice, corn and tankage.

RICE MEAL

Rice meal is ground hulled rice, and should have practically the same feeding value as brewers rice or hulled rice. The term rice meal has also been applied in other sections to a mixture of rice bran,, rice polish, and ground rice screenings or rice germ, combined in the proportions produced in milling. Connor, South Carolina, (7) found such rice meal to be superior to corn meal for hogs.

CHICKEN-FEED RICE

Chicken-feed rice consists of particles of broken rough rice removed in threshing, together with weed seeds and other foreign materials. The percentage of rice grain will vary considerably. In steer feeding experiments at Lake Charles, Snell (29) found chicken-feed rice worth about 75% as much as corn; while in one experiment in fattening lambs at Baton Rouge, Jackson reported chicken-feed rice to have a value 6% higher than corn. No experiments with chicken-feed rice have been conducted with swine at this station.

The value of chicken feed rice will probably be in proportion to the percentage of sound broken rice. One sample analyzed showed 86% rice grain; 8.8% dirt or inert matter and 5.2% grass and weed seeds. If rough rice has 88% the value of corn, then chicken feed rice containing 86% rice grain should be equal to 75% its weight of corn, but should probably be ground for feeding hogs.

HULLED RICE

Cobb, (6) Iberia Station, La., reported one test with low grade hulled rice for hogs in comparison with corn and brewers rice. The hulled rice proved to be superior to corn and only a little less valuable than brewers rice, putting on gains for only 2.5% more feed per 100 lbs. gain than brewers rice.

VITAMINS IN RICE FEEDS

Whole rice, rice bran, and rice polish are excellent sources of the Vitamin B complex and of Vitamin E. What was once called Vitamin B is now known to be a group of different chemical substances necessary to animal health in various ways. The Vitamin B group is principally found in the seed coats and germ of grains, in well-cured roughages and other feeds, and appears to be of importance in the nutrition of swine. Under normal conditions there is no lack of Vitamin B in swine rations. Hughes, California, (15) has shown that in certain restricted rations the addition of one or more substances of the Vitamin B group in an extract of rice bran was effective in increasing growth in pigs. Vitamin E, the fertility vitamin, is found in rice germ, green feeds and well-cured roughages, but has not been shown to be needed by swine.

Rice polish is one of the richest sources of Vitamins B-1 and Nicotinic Acid and is now being used in increasing quantities by medical laboratories for extracting these vitamins for human consumption. There is also a growing demand for bolted rice polishings to be used for human consumption to take the place of wheat flour or to be mixed with it for the sake of its vitamin content.

Brewers rice and rice screenings have no vitamin content and should not be fed for long periods of time unless supplemented with pasture or vitamin containing feeds. Cobb (6) found that a mixture of brewers rice, rice polish and protein supplement made a very efficient fattening ration. The rice products are all deficient in Vitamins A and D, but this is not very important. Vitamin D is not needed by animals that have free access to sunlight. Lack of Vitamin A may cause various degrees of blindness, but as it is found abundantly in green pasture, yellow corn, or green well cured legume hay there is no reason for swine to suffer from lack of this vitamin.

PASTURES

Pastures are especially important at the present time (1943) when there is likely to be a serious shortage of concentrate feeds. Clover pastures are particularly valuable. In one test on red clover pasture for fattening pigs, one-half acre pasture replaced 588 pounds of feed in 56 days.

Winter oats appears to be the most reliable and satisfactory pasture for winter grazing. Dwarf Essex rape sown with oats makes an excellent addition to oat pasture in sections where it will grow. Other winter cover crops may be grazed but as a rule are not available as early in the winter as oats. Sudan grass pastures make good summer grazing. Oats and Sudan pastures have been shown to replace from 600 lbs. to 900 lbs. of concentrate per acre of pasture in three to four months. While much of the experimental work reported here has been done on half acre plots it is not necessary or advisable to confine hogs to such small areas. Pastures for young pigs especially should be fresh pasture rather than old grass pastures on which hogs have been grazing for several years. Plowing and reseeding helps to control parasites.

EXPERIMENTS IN FEEDING RICE AND RICE BYPRODUCTS TO SWINE: COMPARISONS OF WINTER AND SUMMER PASTURES AND PROTEIN AND MINERAL SUPPLEMENTS

EXPERIMENT I

COMPARISONS OF CORN, BREWERS RICE, AND WINTER PASTURES — 1932

Hogs Used

The hogs used were principally high grade Durocs raised by a local breeder; and eight purebred pigs from the University herd.

Rations

Lot 1. Dry Lot. Corn, protein mixture No. 2. Self-fed.

Lot 2. Pasture. Corn, protein mixture No. 1, Protein hand-fed.

Lot 3. Dry Lot. Brewers rice, protein mixture No. 1. Self-fed.

Lot 4. Pasture. Brewers rice, protein mixture No. 1. Self-fed.

Lot 5. Dry Lot. Corn, protein mixture No. 1. Self-fed.

Lot 6. Pasture. Corn, protein mixture No. 1. Self-fed.

Protein Mixtures

Protein mixture No. 1—shrimp meal 60%, cottonseed meal 40%.

Protein mixture No. 2—shrimp meal 5 parts, cottonseed meal 3 parts, ground dehydrated soybean hay 1 part.

Plan of Experiment

The forty-eight hogs were divided into six lots, equal in weight and type. All lots were full-fed in self-feeders with the exception of Lot 2, in which the protein supplement was hand fed. With the exception of Lot 1, the protein supplement was made up of shrimp bran 60%, cottonseed meal 40%. The supplement for Lot 1 was shrimp meal 56%, cottonseed meal 33%, and ground dehydrated soybean hay 11%

Pastures

Three half-acre lots seeded to Texas Red Rustproof oats and Dwarf Essex rape in September were grazed by Lots 2, 4, and 6. Due to the mild winter, all pastures grew well and there was plenty of pasture in all three lots. The pigs in Lot 6 had eaten all their rape by the end of the test.

TABLE XI. AVERAGE WEIGHTS, GAINS, FEED CONSUMED, AND COST PER 100 POUNDS GAIN.

8 pigs per lot Feeding period December 12, 1931 to February 10, 1932 60 Days

LOT NO.	1	2	3	4	5	6
RATION	Shelled Corn Protein Mixture No. 2 (with ground soybean hay) Dry lot	Shelled Corn Limited Protein Mixture No. 1 Pasture	Brewers Rice Protein Mixture No. 1 Dry lot	Brewers Rice Protein Mixture No. 1 Pasture	Shelled Corn Protein Mixture No. 1 Dry lot	Shelled Corn Protein Mixture No. 1 Pasture
Average initial weight	91.3	91.3	91.0	92.0	92.0	91.0
Average final weight	187.6	185.1	208.2	200.5	189.3	188.6
Average gain	96.3	93.8	117.2	108.5	97.3	97.6
Average daily gain	1.6	1.56	1.95	1.81	1.62	1.63
Average daily feed						
Corn	5.9	5.4	....	....	5.38	5.62
Brewers rice	....	....	6.83	6.3	....	....
Protein mixture	.72	.325	.44	.33	.71	.42
Minerals	.013	.0077	.0073	.002	.013	.004
TOTAL DAILY FEED	6.63	5.73	7.27	6.63	6.10	6.04
Feed per 100 lbs. gain						
Corn	366.5	346.3	....	....	331.8	345.9
Brewers rice	....	....	349.9	349.8	....	....
Shrimp meal	23.6	12.5	13.4	11.0	26.3	15.4
Cottonseed meal	15.7	8.3	9.0	7.3	17.3	10.3
Dehydrated ground soybean hay	5.8	....	....	....	....	....
Minerals	.82	.5	.37	.115	.81	.23
TOTAL	412.42	367.6	372.7	368.2	376.2	371.8
Cost per 100 lbs. gain	$4.65	$4.08	$3.13	$3.12	$4.30	$4.15

FEED PRICES: Corn 60c per bushel, $21.43 per ton
Brewers rice $16 per ton
Shrimp meal $45 per ton
Cottonseed meal $18 per ton
Soybean hay $12 per ton

Feeds

The corn was Yellow Creole, shelled and fed in self-feeders. The brewers rice was a good grade of brewers rice. The shrimp bran was high-grade dehydrated meal.

CONCLUSIONS

1. Brewers rice was equal to corn for fattening hogs. The pigs receiving brewers rice ate less protein, and slightly more grain than did the

pigs on corn. At $16 per ton for brewers rice, the cost per 100 pounds gain was $1.10 less than with corn at 60c per bushel.

2. Pigs on pasture consumed 35% less protein supplement for each 100 pounds gain than did pigs in dry lots.
3. Hand feeding the protein supplement in limited amounts saved about 30c per 100 pounds gain, which would not be sufficient to pay for the extra labor.
4. Ground dehydrated soybean hay added to the protein supplement did not prove satisfactory. This group of pigs made the least economical gains.
5. Brewers rice showed the following values per ton with corn at various prices per bushel:

COMPARATIVE VALUES OF CORN AND BREWERS RICE AT VARIOUS PRICES FOR CORN

Corn price per bushel	Brewers Rice Value per Ton
50 cents	$17.85
60 "	21.42
70 "	25.00
80 "	28.56
$1.00	35.70
$1.10	39.25

6. Oats and rape pastures did not show a high value in this experiment but reduced the amount of protein supplement per 100 pounds gain about 35%.

ANALYSIS OF FEEDS

	Crude Protein	Fat	Nitrogen Free Extract	Crude Fiber	Water	Ash
Yellow Creole corn	10.25	5.20	69.60	1.95	11.45	1.56
Brewers rice	7.94	0.55	76.96	0.65	12.80	1.10
Shrimp meal	43.88	2.00	0.42	10.00	11.85	31.85
Cottonseed meal	41.25	.....	.....	.....	.....	.....
Green rape	2.89	.54	2.90	2.67	89.47	1.53
Green oats	2.66	.54	2.90	2.84	89.13	1.95
Soybean hay meal	12.94	2.05	32.56	34.05	9.15	9.25

EXPERIMENT II

RICE BRAN AND CORN IN VARIOUS COMBINATIONS COMPARED WITH CORN ALONE; COMPARISON OF PROTEIN SUPPLEMENTS; VALUE OF WINTER PASTURE — 1933

Hogs Used

The hogs were purebred sows and barrows owned by the University.

Plan of Experiment

The hogs were fed in self feeders, the carbohydrate ration, either corn or corn and rice bran, being fed in one compartment, the protein supplement in another, and the mineral mixture in a third compartment, all fed free choice. Lot 7 had one-half acre of winter oats and rape pasture adjoining the regular feeding lot. The mineral mixture consisted of one part salt, two parts ground oyster-shell, and one part steamed bone meal. The purpose of the experiment was to compare various protein supplements and various levels of feeding rice bran, also to determine the value of oats and rape pasture.

CONCLUSIONS

1. The largest gain made in dry lot was made in Lot 3 on a ration of 75% corn and 25% rice bran with a protein supplement of 5 parts shrimp meal, 3 parts cottonseed meal, and 2 parts ground alfalfa. This lot was also one of the two dry-lot groups making the most economical gains.
2. Lot 7 on a half-acre pasture of winter oats and Dwarf Essex rape made 12.8% faster gains than hogs fed the same ration without pasture (Lot 4), and required 70 pounds less feed per 100 pounds gain. This was equal to 848 pounds feed saved per half-acre pasture. At 1943 feed prices, the pasture would have been worth $16.00 to $20.00 per half acre.
3. The most economical dry-lot ration, (Lot 5) was corn 70 parts, and rice bran 30 parts, with supplement. At the start, this lot received 60% corn and 40% rice bran with the rice bran later reduced.
4. Lot 6 receiving a protein mixture of 5 parts shrimp meal, 6 parts rice bran, and 2 parts ground alfalfa did not do well. Some of the hogs made good gains, but a few made unsatisfactory growth from some cause, probably not connected with the ration fed.
5. Hogs on pasture in Lot 7 ate only one-third as much mineral matter per 100 pounds gain as was eaten in the average dry lot.
6. In Lots 1 and 2 receiving corn without rice bran, the protein mixture of shrimp meal and ground alfalfa produced better and more economical gains than a mixture of shrimp meal, cottonseed meal, and

EXPERIMENT II

TABLE XII. AVERAGE WEIGHTS, GAINS, FEED CONSUMED PER DAY, FEED CONSUMED PER 100 POUNDS GAIN AND COSTS OF GAIN

10 hogs per lot — Feeding period December 20, 1932, to March 18, 1933 — 88 days

LOT NUMBER	1	2	3	4	5	6	7
BASIC RATION	Corn	Corn	Corn 75 Rice Bran 25	Corn 75 Rice Bran 25	Corn 70 Rice Bran 30	Corn	Corn 75 Rice Bran 25
PROTEIN SUPPLEMENT	Shrimp Meal 8 Ground Alfalfa 2	Shrimp Meal 5 Ground Alfalfa 2 Cottonseed Meal 3	Shrimp Meal 5 Ground Alfalfa 2 Cottonseed Meal 3	Shrimp Meal 8 Ground Alfalfa 2	Shrimp Meal 8 Ground Alfalfa 2	Shrimp Meal 5 Ground Alfalfa 2 Rice Bran 6	Shrimp Meal 8 Ground Alfalfa 2 Oats and Rape Pasture
Average initial weight	54.8	54.9	54.5	54.5	54.8	55.6	54.9
Average final weight	166.7	146.6	174.9	164.6	164.3	147.6	178.8
Average gain	111.9	91.7	120.4	110.1	109.5	92.0	123.9
Average daily gain	1.27	1.04	1.37	1.25	1.24	1.05	1.41
Average Daily Ration:							
Corn	4.8	4.25	3.7	3.7	3.25	3.67	3.84
Rice Bran	......	......	1.3	1.3	1.45	.43	1.05
Shrimp Meal	.54	.35	.34	.49	.43	.34	.31
Cottonseed Meal	......	.21	.21	......	......	......	......
Alfalfa Meal	.14	.14	.14	.12	.11	.14	.08
TOTAL DAILY FEED	5.48	4.95	5.69	5.61	5.24	4.58	5.28
Feed per 100 pound gain:							
Corn	376.6	408.1	272.2	294.9	261.3	351.3	273.0
Rice Bran	......	......	94.4	101.8	116.6	41.5	74.8
Shrimp Meal	42.7	33.7	25.1	38.9	34.9	32.7	22.1
Cottonseed Meal	......	20.2	15.1	......	......	......	......
Alfalfa Meal	10.7	13.5	10.1	9.7	8.7	13.1	5.53
Mineral	.67	1.14	.91	.54	.82	1.41	.36
TOTAL FEED per 100# gain	430.9	476.6	417.8	445.8	422.3	440.0	375.7
Cost per 100 pound gain	$ 3.30	$ 3.65	$ 2.86	$ 3.06	$2.84	$ 3.20	$ 2.60

COST OF FEEDS: Corn $0.42 per bushel; Rice Bran $8.00 per ton; Shrimp Meal $20.00 per ton; Cottonseed Meal $18.00 per ton; Alfalfa $10.00 per ton.

ground alfalfa. In Lots 3 and 4 receiving rice bran, the addition of cottonseed meal produced larger and more economical gains.

7. Comparing Lot 1 with Lot 5 or Lot 2 with Lot 3, rice bran replaced more than an equal weight of higher priced feedstuffs in producing 100 pounds of pork. With corn at 42c per bushel, rice bran was worth $16.35 per ton fed to Lot 5 or $13.25 per ton fed in Lot 4 as compared to Lot 1. At $1.00 per bushel for corn (1943 prices) rice bran would be worth $32.00 to $39.00 per ton, when fed in these proportions.

EXPERIMENT III

RICE BRAN COMPARED TO WHEAT SHORTS FOR FATTENING HOGS: VALUE OF ALFALFA AND SUDAN GRASS PASTURES — 1933

Hogs Used

The hogs used were practically all purebred sows and barrows produced on the University farm, averaging about 50 pounds in weight and fed to a weight of 125 pounds previous to hogging off sweet potatoes.

Feeds Used

The basic feed mixture was approximately 65% ground shelled corn with 35% of either rice bran or wheat shorts mixed and fed in a self-feeder. The protein mixture consisted of 50% shrimp meal, 30% cottonseed meal, and 20% ground alfalfa mixed and fed in a separate part of the self-feeder. Lot 2 was hand-fed a limited ration, about 3/4 of a full feed.

CONCLUSIONS

1. Rice bran compared favorably with wheat shorts, when both were fed at the rate of one-third of the corn ration. With wheat shorts at $18 per ton, rice bran was worth $18.40 per ton on pasture. Fed in dry-lot, the rice bran was worth slightly less than the shorts. An average of the two tests showed rice bran to be about 96% as valuable as wheat shorts.
2. Sudan grass pasture produced as good gains per acre as alfalfa pasture. The pigs were not able to use all the Sudan grass, which would have possibly carried twice as many head per acre. The alfalfa in Lot 1 was practically all replaced by Bermuda grass by the end of the experiment.
3. A limited ($\frac{3}{4}$) grain ration on pasture produced gains for approximately 25 pounds less feed per 100 pounds gain than when a full feed was given. This saving is insufficient to pay for the labor of daily feeding as compared to the self-feeder.

4. Pigs full-fed grain on pasture made 18.8% more rapid gains than pigs full-fed in dry lots and would have been ready for market approximately two weeks earlier.

TABLE XIII. WEIGHTS, GAINS, FEED CONSUMED AND FEED REQUIRED FOR 100 POUNDS GAIN; AND GRAIN REPLACED BY PASTURE

10 pigs per lot Feeding period May 31-August 12, 1933 73 days

LOT NO.	1	2*	3	4	5	6
PASTURE	Alfalfa	Sudan	Dry Lot	Sudan	Dry Lot	Sudan
RATION	Corn Rice Bran Protein Sup.	Corn Rice Bran Protein Sup.	Corn Rice Bran Protein Sup.	Corn Rice Bran Protein Sup.	Corn Wheat Shorts Protein Sup.	Corn Wheat Shorts Protein Sup.
Average initial weight	49.8	49.5	49.7	49.9	49.5	48.8
Average final weight	127.7	112.4	114.8	129.1	115.6	126.5
Average Gain	77.9	62.9	65.1	79.2	66.1	77.7
Average daily gain	1.07	.86	.89	1.08	.905	1.06
Average feed per day						
Corn	2.40	1.84	2.23	2.47	2.20	2.44
Rice Bran	1.31	1.01	1.22	1.35	....	....
Wheat Shorts	....	....	....	....	1.20	1.33
Shrimp meal	.11	.095	.11	.12	.11	.12
Cottonseed meal	.07	.06	.07	.07	.07	.07
Alralfa Meal	.04	.038	.04	.05	.04	.05
TOTAL FEED PER DAY	3.93	3.04	3.67	4.06	3.62	4.01
Feed per 100# Gain						
Corn	224.9	214.1	250.3	228.0	242.5	229.6
Rice Bran	123.1	117.1	137.0	124.4	....	....
Wheat Shorts	....	....	....	....	132.2	125.4
Shrimp Meal	10.6	9.9	12.4	11.4	12.3	11.6
Cottonseed Meal	6.4	5.9	7.5	6.8	7.4	6.9
Alfalfa Meal	4.2	4.0	5.0	4.6	4.9	4.6
TOTAL FEED PER 100# GAIN	369.2	351.0	412.2	375.2	399.3	378.1
Cost per 100# gain at market prices for feed	$3.02	$ 2.87	$ 3.37	$ 3.07	$ 3.87	$ 3.66
Pounds feed replaced by 1/2 acre pasture (73 days)	334	385	....	293	....	165
Value per acre pasture for 73 days with feed at 1c per pound	$ 6.68	$ 7.70	....	$ 5.96	....	$ 3.29
1 3/4c per pound	$11.69	$13.51	....	$10.43	....	$ 5.75

*All lots full-fed but Lot 2, fed a 3/4 ration.

PRICES OF FEEDS:	Corn	$20.00 per ton	Shrimp Meal	$25.00 per ton
	Rice Bran	9.00 " "	Cottonseed Meal	18.00 " "
	Wheat Shorts	18.00 " "	Ground Alfalfa	10.00 " "

5. Pastures showed a value of $6.00 to $7.70 per acre (1934 prices) with ten pigs per half acre of the pastures, replacing over 300 lbs. feed per half acre. At $2.00 per 100 lbs. feed (1943 prices) this

would be equal to over $12.00 per acre for 10 pigs fed 73 days. The Sudan grass pasture would have supplied at least two more months of pasturing, after the close of the test. Sudan grass is to be recommended for summer hog pasture, but should be mowed occasionally.

ANALYSIS OF FEEDS

	Rice Bran	Wheat Shorts
Crude Protein	13.38	17.31
Fat	10.25	3.30
Nitrogen Free Extract (Carbohydrates)	44.22	58.69
Crude Fiber	11.75	6.15
Water	9.10	10.30
Ash	11.30	4.25

EXPERIMENT IV

RICE PRODUCTS AND PASTURES FOR FATTENING SWINE — 1934

This experimental work was conducted at the Iberia Livestock Experiment Station at Jeanerette, Louisiana, under a cooperative agreement between the Louisiana Experiment Station and the Bureau of Animal Industry, U. S. Department of Agriculture.

Objects of Experiment

To determine: (1) the value of rice bran and rice polish for fattening swine when fed in combination with corn; (2) the effect of medium amounts of rice by-products on hardness of fat; and (3) the value of clover pasture and oat pastures for fattening hogs.

Pastures

The oats rusted badly and did not provide quite enough grazing for the hogs in these lots. By the end of the experiment, the oats had been replaced entirely by native grass. The red clover pasture, was in good condition and provided plenty of grazing.

Plan of Experiment

Seventy fall Tamworth pigs, averaging approximately 63 pounds initial weight, were divided into seven lots and fed by the self-feeder method, the basal feeds and the protein supplements being fed in separate compartments. The protein mixture was made up of two parts shrimp meal to one part cottonseed meal, the same for each lot.

THE RATIONS FED WERE AS FOLLOWS:

Lot No.	Basal Ration	Pasture or Dry Lot
1	Corn	Oat Pasture
2	Corn	Dry Lot
3	Corn 2, Rice Polish 1	Oat Pasture
4	Corn 2, Rice Polish 1	Dry Lot
5	Corn 4, Bran 1, Polish 1	Oat Pasture
6	Corn 2, Rice Polish 1	Red Clover Pasture
7	Corn 2, Wheat Shorts 1	Oat Pasture

A mineral mixture of 20 parts salt, 40 parts steamed bone meal, and 40 parts fine-ground oyster shell was available in each lot.

Tamworth pigs on red clover pasture gained faster than those in dry-lot. One-half acre of pasture replaced 588 lbs. of feed in 56 days.

CONCLUSIONS

1. Rice polish proved to be profitable when fed at the rate of one-third of the corn ration. On winter oat pasture, the saving amounted to 66c per 100 pounds gain. One hundred pounds of rice polish apparently replaced 120 pounds corn. In the dry lot comparison (Lots 2 and 4), the use of rice polish saved 43c in cost per 100 pounds gain, with no saving in amount of feed consumed.
2. The substitution of rice bran for half the rice polish in Lot 5 did not prove profitable. The lot receiving this ration made the lowest gains, which may have been due to other causes.
3. Rice polish was more profitable than wheat shorts as a supplement to corn. When wheat shorts replaced one-third of the corn, it pro-

TABLE XIV. WEIGHTS, GAINS, FEED PER DAY, AND FEED REQUIRED PER 100 POUNDS GAIN, 1934

10 pigs per lot — Feeding period March 22 to May 17, 1934 — 56 days

LOT NO.	1	2	3	4	5	6	7
RATIONS	Corn Shrimp Meal Cottonseed Meal	Corn Shrimp Meal Cottonseed Meal	Corn 2 Rice Polish 1 Shrimp Meal Cottonseed Meal	Corn 2 Rice Polish 1 Shrimp Meal Cottonseed Meal	Corn 4 Rice Polish 1 Rice Bran 1 Shrimp Meal Cottonseed Meal	Corn 2 Rice Polish 1 Shrimp Meal Cottonseed Meal	Corn 2 Wheat Shorts 1 Shrimp Meal Cottonseed Meal
PASTURE	Oat Pasture	Dry Lot	Oat Pasture	Dry Lot	Oat Pasture	Red Clover Pasture	Oat Pasture
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Average initial weight	63.1	63.4	63.1	63.8	63.4	63.7	63.5
Average final weight	158.1	158.8	162.7	156.0	151.0	170.0	157.9
Average gain	95.0	95.4	99.6	92.2	87.6	106.3	94.4
Average daily gain	1.70	1.70	1.78	1.65	1.56	1.90	1.68
Average daily feed:							
Corn—ground	5.7	5.8	3.81	3.78	3.67	3.72	3.97
Rice Polish	......	......	1.90	1.89	.92	1.86	......
Rice Bran	......	......	......	......	.92	......	......
Wheat Shorts	......	......	......	......	......	......	1.98
Shrimp Meal	.23	.26	.24	.25	.285	.22	.25
Cottonseed Meal	.115	.13	.12	.125	.142	.11	.125
TOTAL DAILY FEED	6.05	6.19	6.07	6.05	5.93	5.91	6.33
Feed per 100 pounds gain:							
Corn Chops	336.5	340.7	214.1	231.0	234.3	196.3	235.4
Rice Polish	......	......	107.1	113.9	58.5	98.15	......
Rice Bran	......	......	......	......	58.5	......	......
Wheat Shorts	......	......	......	......	......	......	117.7
Shrimp Meal	13.60	15.31	13.45	14.97	18.26	11.57	14.8
Cottonseed Meal	6.8	7.65	6.72	7.48	9.13	5.78	7.4
TOTAL FEED per 100# gain	356.9	363.7	341.3	367.4	378.7	311.80	375.3
Feed Cost per 100#gain	$ 4.85	$ 4.94	$ 4.19	$ 4.51	$ 4.47	$ 3.82	$ 4.96

FEED PRICES: Corn $27.40; Shrimp Meal $23.60; Wheat Shorts $25.00; Rice Bran $13.00; Rice Polish $19.00; Cottonseed Meal $23.50

duced practically the same gains as corn alone at a slightly increased cost.

4. The winter oats rusted badly and were not in good condition for pasture in March. With the corn and rice polish ration, winter oats showed an apparent value of $7.40 per acre ($3.70 per ½ acre) at 1934 feed prices. There was little apparent advantage from oat pasture in the corn fed lots, both groups making the same gains.

5. The pigs on red clover pasture (Lot 6) gained faster than any other lot and made the most satisfactory gains for feed consumed. One-half acre of clover pasture replaced 588.4 pounds feed in 56 days, or 1176.7 pounds per acre, worth approximately $15.00 to $16.00 per acre at 1934 feed prices. At 1943 feed prices, the value per acre would be doubled or about $32.00 per acre with corn at $55.00 per ton.

Hardness of Fat as Affected by Feed

All carcasses were satisfactorily firm according to the buyers. The following table shows the average refractive index of leaf fat samples taken in the different lots: The determinations were made by the Department of Nutrition Investigations of the U. S. Department of Agriculture at Beltsville, Maryland.

Effect of Feed on Hardness of Fat*

Lot No.		Refractive Index	Average Grade
1	Corn-Oat Pasture	1.45945	Hard
2	Corn-Dry Lot	1.45955	Hard
3	Corn-Rice Polish-Oat Pasture	1.4597	Med. Hard
4	Corn-Rice Polish-Dry Lot	1.45978	Med. Hard
5	Corn-Rice Polish-Rice Bran-Oat Pasture	1.45995	Med. Hard
6	Corn-Rice Polish-Clover Pasture	1.4600	Med. Hard
7	Corn-Wheat Shorts-Oat Pasture	1.4593	Hard

Fat samples were taken from approximately half of the carcasses. The hogs fed rice products showed softer fat than those on corn or corn and wheat shorts. In scoring the carcasses in the cooler, the carcasses from hogs fed the rice products averaged one grade lower on hardness, although all were satisfactory. No consistent difference was observed in regard to the effect of pasture on hardness of fat, with the exception of the clover lot which gave a slightly higher index reading.

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* In estimating various degrees of hardness in fats by means of the refractive index, the following readings for the different grades are suggested by the U. S. Department of Agriculture: (13) Hard 1.4597 and below; medium hard, 1.4598 to 1.4601; medium soft, 1.4602 to 1.4605; soft, 1.4606 to 1.4618; and oily 1.4619 and above.

EXPERIMENT V

RICE PRODUCTS AND WINTER OAT PASTURES FOR SWINE — 1935

Conducted at the Iberia Livestock Experiment Farm at Jeanerette, Louisiana, under a cooperative agreement between the Louisiana Experiment Station and the Bureau of Animal Industry, U. S. Department of Agriculture.

Objects

The objects were to determine: (1) the value of rice bran and rice polish for fattening swine when fed in suitable combinations with corn; (2) the effect of medium amounts of rice polish and rice bran on the quality of pork; and (3) the value of winter oat pasture for fattening swine.

Hogs Used

The pigs were purebred Tamworth gilts and barrows owned by the Iberia Livestock Experiment Farm, weighing about 45 pounds each at the start of the test.

Pasture

The only pastures used in this test were winter oats. The pastures were in excellent shape at the beginning of the experiment but two hard freezes soon afterwards destroyed approximately two-thirds of the existing green feed. The pigs kept the pastures eaten down closely for the remainder of the test. Lots 1 and 3 had one-half acre of oat pasture each.

Feeds

The feeds used were ground yellow corn with rice bran and rice polish from the local rice mills, mixed and fed in self-feeders. The protein supplement was two parts dehydrated shrimp meal and one part cottonseed meal, fed free choice in a separate compartment of the feeders. A mineral mixture of two parts steamed bone meal, two parts fine-ground oystershell, and one part salt was fed in another compartment.

CONCLUSIONS

1. Winter oat pastures, even when damaged by hard freezes, proved profitable at 1935 feed prices. Pastures saved 54 pounds feed per pig in the corn lots, equal to $1.10 per head, or 540 lbs. feed per half acre of oats. In the lots fed corn and rice polish, the saving was at the rate of 90 pounds of feed per pig, if fed to equal weights, or 900

EXPERIMENT V

TABLE XV. Weights, Gains, Feed Consumed Per Day and Per 100 Pounds Gain and Cost of Gains

10 pigs per lot Feeding period January 26 to May 25, 1935 119 days

Lot No.	1	2	3	4	5	6
Ration	Corn Shr. Meal C. S. Meal	Corn Shr. Meal C. S. Meal	Corn 2 Rice Pol. 1 Shr. Meal C. S. Meal	Corn 2 Rice Pol. 1 Shr. Meal C. S. Meal	Corn 2 Rice Bran 1 Shr. Meal C. S. Meal	Corn 4 Rice Bran 1 Shr. Meal C. S. Meal
Pasture	Oat Pasture	Dry Lot	Oat Pasture	Dry Lot	Dry Lot	Dry Lot
Average initial weight..........	45.7	45.8	45.7	45.4	45.5	45.7
Average final weight...........	221.2	212.3	219.2	202.1	222.6	224.7
Average gain..................	176.5	166.5	173.5	156.7	177.1	179.0
Average daily gain.............	1.48	1.40	1.46	1.316	1.49	1.504
Average daily feed:						
Corn......................	4.92	4.98	3.00	3.09	3.06	3.60
Rice products..............	....	....	1.50	1.54	1.53	.90
Protein supplement..........	.46	.54	.50	.57	.60	.63
Total daily feed.............	5.38	5.52	5.00	5.20	5.19	5.13
Feed per 100 pounds gain:						
Corn......................	331.7	356.4	205.4	234.3	205.9	239.7
Rice Polish.................	....	....	102.7	117.2	....	....
Rice Bran..................	....	....	....	....	102.9	59.9
Shrimp Meal................	20.8	25.8	23.0	29.1	26.8	28.0
Cottonseed Meal............	10.4	12.9	11.5	14.5	13.4	14.0
Total feed per 100# gain......	362.9	395.1	342.6	395.1	349.0	341.6
Feed cost per 100# gain not including pasture............	$ 7.53	$ 8.17	$ 6.66	$ 7.67	$ 6.31	$ 6.50
Estimated value per pig @ 7c...	$ 3.20	$ 3.20	$ 3.20	$ 3.18	$ 3.19	$ 3.20
Total feed cost................	$13.12	$13.60	$11.56	$12.02	$11.18	$11.64
Marketing cost................	$ 1.68	$ 1.61	$ 1.68	$ 1.53	$ 1.69	$ 1.70
Sale weight per pig, lbs	213.46	204.9	211.5	195.03	214.8	216.84
Sale value per pig @ 9c........	$19.21	$18.44	$19.04	$17.55	$19.33	$19.51
Sale value, less market cost......	$17.53	$16.83	$17.36	$16.02	$17.64	$17.81
Net return....................	$ 1.21	$ 0.03	$ 2.60	$ 0.82	$ 3.27	$ 2.97

*Lot 4 had only 9 pigs.

Feed Prices per ton:			
Corn...........	$42.50	Rice Bran...........	$25.70
Shrimp Meal....	25.00	Cottonseed Meal.....	42.00
Rice Polish.....	34.50		

lbs. feed replaced by one-half acre of oat pasture. The cost of seed oats was 8.5 cents per pig.

2. The most profit was made in Lots 5 and 6, fed corn and rice bran. The lot fed four parts corn to one part rice bran (Lot 6) made the most rapid gains, but the lot fed two parts corn to one part rice bran (Lot 5) showed the greatest profit over feed cost. In this test,

corn and rice bran was superior to corn and rice polish, or to corn alone. The use of one-third rice bran to replace an equal amount of corn is to be recommended in the rice section. In Lot 6, 60 pounds of rice bran replaced nearly twice its weight of other feeds.

Winter oat pastures make good winter grazing and replaced 800 to 900 lbs. of feed per half acre during a 119 day feeding period.

3. The ration of rice polish and corn did not show as good returns from the polish as was made from bran. The lot receiving corn and polish in dry lot (Lot 4) required the same amount of feed per 100 pounds gain as Lot 2 fed corn alone but made slightly more profit. The lot fed rice polish and corn, with oat pasture (Lot 3) put on gains for less feed per 100 pounds gain than did the lot on corn, with oat pasture, and made twice as much profit on about the same gains per day.
4. The carcasses from all lots proved acceptable on the New Orleans market. There was no objectionable softness produced by the rice bran or rice polish.

Determination of Hardness of Fat

One way of determining the hardness or softness of fats is by the refractive index. The following table gives the refractive index for leaf fat samples taken from 7 to 9 hogs from each lot. The determinations were made at Beltsville, Maryland, in the laboratories of the Bureau of Animal Industry of the Department of Agriculture.

EFFECT OF FEED ON HARDNESS OF FAT*

Lot No.	RATION	Pasture	Refractive Index Average	Range	GRADE
1	Corn..................	Oat Pasture....	1.4589	1.4587–14595	Hard
2	Corn..................	Dry Lot.......	1.4588	1.4587–14590	Hard
3	Corn 2, Rice Polish 1....	Oat Pasture....	1.45950	1.4593–14599	Hard to Med Hard
4	Corn 2, Rice Polish 1....	Dry Lot.......	1.45956	1.4592–14599	Hard to Med. Hard
5	Corn 2, Rice Bran 1.....	Dry Lot.......	1.4597	1.4594–14600	Hard to Med. Hard
6	Corn 4, Rice Bran 1.....	Dry Lot.......	1.4594	1.4592–14600	Hard to Med. Hard

*In determining degrees of hardness in fats by means of the refractive index, the following readings for the different grades are suggested by the U. S. Department of Agriculture: (13) Hard 1.4597 and below; medium hard, 1.4598 to 1.4601; medium soft, 1.4602 to 1.4605; soft, 1.4606 to 1.4618; and oily 1.4619 and above.

The two lots fed corn (Lots 1 and 2) would have graded as hard and lots 3 to 6 would have graded hard to medium hard, with a few medium soft. The buyers pronounced all the carcasses good. Pastures showed no effect on hardness of fat.

EXPERIMENT VI

RICE PRODUCTS, WINTER PASTURES, AND MINERAL MIXTURES FOR FATTENING SWINE — 1937

Hogs Used

Purebred Duroc-Jersey pigs from the Iberia Livestock Experiment Farm herd, farrowed in September and October were used in this test, averaging approximately 85 pounds each at the start of the test. They had been carried from weaning time on winter oat pasture with a limited grain ration, and were in good condition when put on test.

Pastures

The two lots on pasture had one-half acre of winter oats each. By March 26, when the feeding tests began, the oats had become a little too mature to make the best grazing. By the end of the test, the oats had headed out.

Method of Feeding

The basic rations of corn or corn and rice products were mixed together and fed in self-feeders. The protein supplement was a mixture of shrimp meal 2 parts and cottonseed meal 1 part, and was fed in a separate compartment. The mineral supplements were fed at the rate of 1 percent of the basal ration.

Mineral Mixtures

One of the objects of the test was to determine whether a mineral mixture of 80 parts ground oyster shell and 20 parts common salt would be as effective as a mixture of 40 parts ground oyster shell, 40 parts spent bone black, and 20 parts salt. This spent bone black, also called bone char, is bone meal that has been used in the sugar refineries for clarifying sugar, and is similar to steamed bone meal in mineral content.

RATIONS FED, PASTURES, AND MINERAL MIXTURES

Lot No.	BASAL RATION	Pasture	Mineral Mixture
1	Corn	Winter Oats	I*
2	Corn 200, Rice Bran 100	None	I
3	Corn 200, Rice Bran 100	Winter Oats	I
5	Corn 200, Rice Bran 100	None	II*
6	Corn 200, Rice Polish 100	None	I
7	Corn 200, Rice Polish 100	None	II

*Mineral mixture I consisted of bone black 40 parts, ground oyster shell 40 parts, and salt 20 parts. Mineral mixture II consisted of ground oyster shell 80 parts and salt 20 parts.

Grading

At the end of the test the pigs were graded and shipped to New Orleans for slaughter, the carcasses graded, and measurements taken of the carcasses according to the system used by the U. S. Department of Agriculture. The measurements are not included in this report.

Marketing

The hogs sold at $10.50 per 100 pounds (market weights), which was one-half cents above regular market price. The net return was $9.96 per 100 pounds after allowing for sale costs or $9.50 per 100 pounds feed-lot weights. On May 20, twenty-four of the heaviest hogs were taken off test and nineteen of these shipped to market. The remainder were shipped on June 10, a few gilts being retained as breeding stock. This makes some variation in the average number of days for the different lots. It is assumed that the prices and the percent shrinkage would be the same for the six sows kept back as for the fifty-nine hogs shipped to market.

CONCLUSIONS

1. The groups fed corn and rice polish made the most rapid and economical gains. The rice polish lots made 9.2 per cent greater gains than the corn lot (Lot 1). It apparently required about 83.7 pounds of rice polish to replace 100 pounds of corn, when fed in place of one-third of the corn.
2. Lot 3 fed corn and rice bran made 4.3 per cent greater gains than Lot 1 on corn alone, but ate 6.85 per cent more feed, making the net

EXPERIMENT VI

TABLE XVI. Weights, Gains, Feed Consumed Per Day and Per 100 Pounds Gain and Cost of Gains

11 pigs per lot

March 26 to May 20 and June 9, 1937

55 to 75 days

Lot	1	2	3	5	6	7
Ration	Corn, Protein Supplement, Min. Mix. I Oat Pasture	Corn, Rice Bran, Protein Supplement, Min. Mix. I Dry Lot	Corn, Rice Bran, Protein Supplement, Min. Mix. I Oat Pasture	Corn, Rice Bran, Protein Supplement, Min. Mix. II Dry Lot	Corn, Rice Polish, Protein Supplement, Min. Mix. I Dry Lot	Corn, Rice Polish Protein Supplement, Min. Mix. II Dry Lot
Average days on test	69.5	67.7	67.7	67.7	66	67.7
Average initial weight, pounds	85.3	85.6	85.5	84.7	84.8	85.4
Average final weight, pounds	212.8	213.1	215.8	209.5	218.2	221.1
Average gain, pounds	127.5	127.5	130.3	124.8	133.4	135.7
Average daily gain, pounds	1.84	1.88	1.92	1.84	2.02	2.00
Average Daily Feed:						
Corn, pounds	7.23	5.11	5.16	5.04	4.98	4.95
Rice Bran, pounds	......	2.56	2.58	2.52	......	......
Rice Polish, pounds	......	......	......	......	2.49	2.47
Protein Mixture, pounds	.21	.21	.21	.21	.20	.21
TOTAL FEED PER DAY	7.44	7.88	7.95	7.77	7.67	7.63
Feed per 100 pounds gain:						
Corn, pounds	393.2	271.6	268.3	274.3	246.2	247.2
Rice Bran, pounds	......	135.8	134.1	137.2	......	......
Rice Polish, pounds	......	......	......	......	123.1	123.6
Shrimp Meal, pounds	7.75	7.42	7.32	7.50	6.49	7.05
Cottonseed Meal, pounds	3.87	3.71	3.66	3.80	3.25	3.53
Mineral Mixture, pounds	3.9	4.0	4.0	4.1	3.7	3.7
TOTAL FEED per 100# gain	408.7	422.5	417.4	426.9	382.7	385.1
Cost per 100 pounds gain	$10.33	$ 9.32	$ 9.35	$ 9.64	$ 9.08	$ 9.05
Value of feeder pigs @ $8 per 100#	$ 6.82	$ 6.85	$ 6.84	$ 6.78	$ 6.78	$ 6.83
Average feed cost per head	$13.18	$11.89	$12.18	$11.64	$12.10	$12.28
TOTAL COST PER HEAD	$20.00	$18.74	$19.02	$18.42	$18.88	$19.11
Net sale value @ $9.50 per 100#	$20.21	$20.24	$20.50	$19.90	$20.72	$21.00
Net balance, corn @ $50.00 per ton	$ 0.21	$ 1.50	$ 1.48	$ 1.48	$ 1.84	$ 1.89

COST OF FEEDS: Corn, per ton $50.00; (per bushel $1.40); Rice Bran, per ton $32.00; Rice Polish, per ton $42.00; Oat Pasture, per half-acre $2.00; Shrimp Meal, per ton

TABLE XVII. CARCASS GRADES AND GRADES ON FIRMNESS OF FAT BY LOTS

LOT NO.	1	2	3	5	6	7
RATION	Corn	Corn Rice Bran	Corn Rice Bran	Corn Rice Bran	Corn Rice Polish	Corn Rice Polish
PASTURE	Pasture	Dry Lot	Pasture	Dry Lot	Dry Lot	Dry Lot
MINERAL MIXTURE	I	I	I	II	I	II
			CARCASS GRADE			
TOTAL SLAUGHTERED	10	9	8	10	10	11
Prime +	..	..	..	..	..	1
Prime	..	1	2	..	3	1
Prime −	3	2	2	3	3	3
Choice +	5	4	3	2	2	4
Choice	2	2	1	2	1	2
Choice −	..	..	..	3	1	..
			GRADES ON HARDNESS OF FAT			
Hard	8	2	2	3	1	1
Hard −	2	1	..	1	2	5
Medium Hard	..	3	3	2	2	2
Medium Hard −	..	2	2	1	2	2
Medium Soft	..	1	1	1	2	1
Medium Soft −	..	..	..	1	..	..
Soft	..	..	..	1	..	..
AVERAGE	Hard	Med. Hard	Med. Hard	Med. Hard	Med. Hard	Med. Hard

feed requirement 2.1 per cent greater than corn per 100 pounds gain. In this test it required 107.3 pounds of rice bran to equal 100 pounds corn.

3. The oat pastures did not show as high a value as in previous tests, the oats being too mature. Charging for the half-acre pastures at $2.00 each, including 90 cents for seed and $1.10 for labor, Lot 3 on pasture made only slightly more economical gains than Lot 2, without pasture. No charge is made for pasture in estimating feed costs but at $2.00 per half-acre the extra charge for pasture would be about 18c per head.

4. Hogs receiving a mineral mixture of 40 parts bone-black, 40 parts ground oyster shell, and 20 parts salt made slightly larger gains than those receiving 80 parts ground oyster shell and 20 parts salt with no bone-black. In the lots receiving rice polish there was practically no difference in gains from the two mineral mixtures. Since rice bran, rice polish and cottonseed meal are high in phosphorus there is evidently no need to buy bone meal or bone-black to supply additional phosphorus for fattening hogs. However, as the bone-black

cost only 8c per pig, there was little difference in cost. For brood sows and other breeding stock and for small pigs, the use of some bone meal or bone-black is advisable.

5. At $50.00 per ton, it was unprofitable to feed corn as the only fattening feed. The use of rice bran or rice polish to replace part of the corn made an apparent profit of around $1.50 per head, not including labor.

EXPERIMENT VII

ROUGH RICE AND RICE SCREENINGS COMPARED TO CORN FOR FATTENING HOGS

Rough Rice for Fattening Swine

As inquiries are frequently received regarding the feeding value of damaged rough rice for hogs, a three year test was begun in 1938 to compare ground rough rice with corn; the rice replacing either half or all of the corn in the ration. During some seasons a varying amount of rice may become heated or otherwise damaged, or may contain so much red rice that it will not bring a good price. Such rough rice is frequently used for feeding purposes in the rice area and can be used satisfactorily for feeding hogs as well as other livestock.

Hogs Used

The hogs used were Poland Chinas, Durocs, and cross-breds belonging to the University, equally divided according to weight, breed, and type. Due to delay in obtaining equipment, the hogs had reached a weight of 126 pounds when feeding was started March 16, 1938. On April 13-20, hogs that had reached weights of 225 pounds and above were taken off test and slaughtered, the lighter hogs being continued on feed until May 4. Carcasses were graded and fat samples taken for determination of hardness of fat. Examination of stomach and intestines for possible effects of rice hulls were made by Prof. J. B. Francioni, who also assisted in grading carcasses.

Feeds Used

The principal feeds used were No. 2 yellow corn, slightly damaged rough rice, and rice screenings. The rice screenings contained approximately 1 percent of indigo. The protein supplement consisted of one-half dehydrated shrimp meal and one-half cottonseed meal. The mineral mixture consisted of 40 percent steamed bone meal, 40 percent fine ground oyster shell, and 20 percent common salt.

Rations fed were as follows, mixed and fed in self-feeders:

Lot 1. Corn (ground) 90%; protein 9%; mineral 1%.
Lot 2. Corn (ground) 45%; ground rough rice 45%; protein 9%; mineral 1%.
Lot 3. Ground rough rice 90%; protein 9%; mineral 1%.
Lot 4. Corn 45%; rice screenings 45%; protein 9%; mineral 1%.

EXPERIMENT VII

TABLE XVIII. WEIGHTS, GAINS, FEED CONSUMED, AND COST OF GAINS

10 pigs per lot March 16 to May 4, 1938

LOT NO.	1	2	3	4
RATION	Corn 90 Protein 9 Mineral 1	Corn 45 Rough Rice 45 Protein 9 Mineral 1	Rough Rice 90 Protein 9 Mineral 1	Corn 45 Rice Screenings 45 Protein 9 Mineral 1
Average Number Days on Test*......	44.8	46.2	44.1	44.8
Average initial weights, pounds.......	127.1	124.7	126.5	128.0
Average final weight, pounds.........	228.2	217.7	219.5	218.95
Average gain, pounds.................	101.1	93.0	93.0	90.95
Average daily gain, pounds...........	2.26	2.01	2.11	2.03
Total Feed per Lot:				
Corn, pounds.....................	3572	1793.6	......	1600.0
Rough Rice, pounds...............	......	1793.6	3631.5	......
Rice Screenings, pounds............	......	......	......	1600.0
Protein Supplement, pounds........	357.2	358.9	363.2	320.0
Mineral Supplement	39.7	39.9	40.3	36.0
TOTAL POUNDS PER LOT..............	3969.0	3986.0	4035.0	3556.0
Average Feed per Day:				
Corn, pounds.....................	7.97	3.9	......	3.57
Rough Rice, pounds...............	......	3.9	8.23	......
Rice Screenings, pounds............	......	......	......	3.57
Protein Supplement, pounds........	.80	.78	.82	.71
Mineral Supplement, pounds.......	.09	.09	.09	.08
TOTAL POUNDS PER DAY.............	8.86	8.67	9.14	7.93
Feed per 100 pounds gain:				
Corn, pounds.....................	353.3	192.8	......	175.9
Rough Rice, pounds...............	......	192.8	390.5	......
Rice Screenings, pounds............	......	......	......	175.9
Shrimp Meal, pounds	17.6	19.3	19.5	17.6
Cottonseed Meal, pounds..........	17.6	19.3	19.5	17.6
Mineral Supplement, pounds.......	3.9	4.3	4.3	3.9
TOTAL, POUNDS.....................	392.4	428.5	433.8	390.9
Cost per 100 pounds gain............	$ 5.91	$ 6.17	$ 5.95	$ 5.45
Dressing percentage, lot weight.......	75.26	75.5	73.6	75.2

COST OF FEEDS: Rice screenings, per ton $25.00; Rough Rice, per ton $27.00; Corn, per ton $30.00; Shrimp Meal, per ton $40.00; Cottonseed Meal, per ton $25.00; Mineral Mixture, per pound 1.2 cents.

*Some of heavier hogs taken off feed April 13 and April 20.

CONCLUSIONS

1. Ground rough rice showed a feeding value of 89% that of No. 2 yellow corn when fed as the only grain; and 81% in Lot 2 when combined with corn. This is opposite to what might be expected

and this result may have been due to some other cause. For Lot 3, fed rough rice alone, the rice at $27 per ton was as economical as corn at $30 per ton.

2. Rice screenings was practically equal to corn on the basis of feed required per 100 pounds gain, and at $25.00 per ton was more economical than corn at $30.00. The hogs receiving 45% rice screenings (Lot 4) appeared to tire of their feed toward the close of the test. The feed consumed per 100 pounds gain was practically the same for Lot 4 as for Lot 1 receiving corn, but the gains were cheaper in the rice screenings lot due to the lower price of screenings.
3. No bad effects could be attributed to the feeding of ground rice hulls.
4. The carcasses graded choice in all lots. The carcasses in Lot 1 (90% corn) were a little fatter and graded slightly higher on total score. No material difference in hardness of fat was shown by the refractive index test.
5. Fine grinding of rough rice is recommended, to avoid any possible injury from the rice hulls.

ANALYSIS OF FEEDS

FEED	Crude Protein	Water	Fiber	Nitrogen Free Extract	Fat	Ash
Rough Rice.......	6.25	11.55	7.35	68.75	1.45	4.65
Corn Chop........	9.38	14.90	2.05	69.37	3.25	1.05
Rice Screenings....	6.56	13.60	.55	77.79	.55	.95
Cottonseed Meal...	39.69	7.85	13.85	25.81	6.70	6.10
Shrimp Meal......	50.44	9.55	11.35	2.36	4.55	21.75

EXPERIMENT VIII

ROUGH RICE AND RICE SCREENINGS COMPARED TO CORN FOR FATTENING HOGS, II

Hogs Used

The hogs used were purebred sows and barrows owned by the University, averaging about 74 pounds in weight.

Feeds Used

The feeds were No. 2 yellow corn, slightly damaged rough rice, and high grade rice screenings. The local rice mill had no damaged rice, and rough rice was shipped from Crowley, 100 miles distant. The cost of trucking is not included. Rice screenings were bought locally. The protein supplement was half shrimp meal and half cottonseed meal. The mineral mixture consisted of 40% steamed bone meal, 40% ground oyster-shell, and 20% salt.

The rations were in the following proportions: 90 per cent grain-fed (corn or rice), 9 per cent protein supplement, and 1 per cent mineral mixture, and the mixture fed in self-feeders.

EXPERIMENT VIII

TABLE XIX. Average Weights, Gains, Feed Consumed Per Day, and Per 100 Pounds Weight and Cost of Gains

Feeding period January 27 to April 27, 1939 91 days

Lot No.	1	2	3	4
Ration	Corn 90% Protein 9% Mineral 1%	Rough Rice 90% Protein 9% Mineral 1%	Corn 45% Rough Rice 45% Protein 9% Mineral 1%	Corn 45% Rice Screenings 45% Protein 9% Mineral 1%
Number of Pigs per Lot:	10	10	10	9
Average initial weight, pounds	74.7	74.9	73.7	75.2
Average final weight, pounds	208.8	234.9	219.8	219.6
Average gain, pounds	134.1	160.0	146.1	144.4
Average daily gain, pounds	1.47	1.76	1.61	1.59
Average feed per head:				
Corn, pounds	491.7	......	271.35	241.65
Rough Rice, pounds	......	576.45	271.35	......
Rice Screenings, pounds	......	......	......	241.65
Shrimp Meal, pounds	24.6	28.825	27.135	24.16
Cottonseed Meal, pounds	24.6	28.825	27.135	24.16
Mineral Supplement, pounds	5.5	6.4	6.0	5.27
Total pounds	546.4	640.5	602.97	536.90
Average daily feed:				
Corn, pounds	5.4	......	2.98	2.66
Rough Rice, pounds	......	6.33	2.98	......
Rice Screenings, pounds	......	......	......	2.66
Shrimp Meal, pounds	0.27	0.315	0.30	0.265
Cottonseed Meal, pounds	0.27	0.315	0.30	0.265
Mineral Supplement, pounds	0.06	0.07	0.065	0.058
Total, pounds	6.00	7.03	6.63	5.91
Feed per 100 pounds gain:				
Corn, pounds	366.75	......	185.90	167.35
Rough Rice, pounds	......	360.27	185.90	......
Rice Screenings, pounds	......	......	......	167.35
Shrimp Meal, pounds	18.36	18.01	18.6	16.73
Cottonseed Meal, pounds	18.36	18.01	18.6	16.73
Mineral Supplement, pounds	4.10	4.0	4.1	3.7
Total, pounds	407.57	400.3	413.1	371.9
Cost per 100 pounds gain	$ 5.19	$ 5.98	$ 5.72	$ 4.73

Cost of Feeds: Rice Screenings, per ton $25.00; Rough Rice, per ton $30.00; Corn, per ton $25.00; Shrimp Meal, per ton $30.00; Cottonseed Meal, per ton $26.00; Mineral Mixture, per pound $0.02.

Rations

Lot 1. Ground corn 90%; protein 9%; mineral 1%.

Lot 2. Ground rough rice 90%; protein mixture 9%; mineral 1%.

Lot 3. Ground corn 45%; ground rough rice 45%; protein 9%; mineral 1%.

Lot 4. Corn 45%; rice screenings 45%; protein 9%; mineral 1%.

Marketing

At the close of the test, when the pigs averaged around 225 pounds weight, six or seven of the heaviest hogs in each lot were shipped to the New Orleans market, where they brought $6.50 per 100 pounds. Samples of back fat were taken, for determining hardness of fat.

CONCLUSIONS

1. The lots receiving rough rice, or rough rice and corn made more rapid gains than the lot on corn. These results are opposite to those obtained in 1938, when the corn lot made the most rapid gains. For some reason, a few pigs in the corn lot did not make good gains and this test may consequently be misleading. The rice used was of better quality than that used in 1938. Ground rice fed as the only grain again made larger and more economical gains than ground rice and corn combined. On the basis of feed consumed per 100 pounds gain, the ground rough rice was practically equal to corn but at $30.00 per ton was more expensive than corn at $25.00. To be profitable as feed, rough rice should sell from 10% to 14% lower than corn.
2. Rice screenings fed with corn were more profitable than corn alone, when selling at the same price per ton. As in 1938, the lot receiving one-half rice screenings with corn ate less feed than those on corn alone, and produced gains for 10 per cent less feed than did the hogs fed corn and ground rough rice.
3. The differences in hardness of fat were not great. The grades on firmness were determined in the cooler and the refractive index determinations made by the State Chemist.

DETERMINATION OF HARDNESS OF FAT BASED OF THE REFRACTIVE INDEX

Lot No.	RATION	Refractive Index Average	Average Grade	Range of Samples
1	Corn	1.4600	Med. Hard	Hard to Soft
2	Rough Rice	1.4598	Med Hard +	Very Hard to Soft
3	Rough Rice, Corn	1.4599	Med Hard	Very Hard to Soft
4	Rice Screenings, Corn	1.4597	Hard	Very Hard to Med. Soft

Analysis of Feeds

Feed	Crude Protein	Water	Fiber	Nitrogen Free Extract	Fat	Ash
Corn Chop	9.81	14.05	1.85	69.84	3.20	1.25
Rice Screenings	7.50	13.05	.50	77.55	.30	.65
Rough Rice	8.50	11.70	9.85	60.60	2.95	6.40
Protein Mixture						
1/2 Cottonseed Meal 1/2 Shrimp Meal	43.38	9.00	10.90	17.27	4.85	14.60

EXPERIMENT IX

ROUGH RICE COMPARED TO CORN FOR FATTENING HOGS, III

Hogs Used

The hogs were Duroc Jerseys from an experimental breeding project conducted by the station and averaged about 82 pounds at the beginning of the test.

Plan of Experiment

The rations were fed in self-feeders, the feed being mixed in the following proportions: 90% grain feed (corn or rice), 9% protein supplement, and 1% mineral mixture. The feeds were No. 2 yellow corn and slightly damaged rough rice purchased from a local feed mill. The protein supplement was at first made up of half shrimp meal and half cottonseed meal. After six weeks, alfalfa meal was included making a mixture of 40% shrimp meal, 40% cottonseed meal, and 20% alfalfa meal. The mineral mixture was the same as in previous tests.

Rations

Lot 1. Ground corn 90%; protein 9%; mineral 1%.

Lot 2. Ground rough rice 90%; protein 9%; mineral 1%.

Lot 3. Ground corn 45%; ground rice 45%; protein 9%; mineral 1%.

Marketing

On April 12, hogs weighing 225 pounds and over were taken out and those not reserved for breeding were slaughtered in the University abattoir. On April 26, all remaining hogs not reserved for breeding were shipped to New Orleans. The carcasses were graded after slaughter and samples of back fat taken for determination of the hardness of fat.

CONCLUSIONS

1. In this experiment, Lot 1, receiving corn made the best gains. This may not be due entirely to the rations fed. The lots were flooded after heavy rains on two occasions and a number of pigs became

unthrifty as a result, more so in Lots 2 and 3, than in Lot 1. Also the rice used in this test was of lower grade than in previous years.

2. On the basis of feed consumed per 100 pounds gain, the ground rough rice lot required 20% more feed per 100 pounds of gain than the corn lot and the lot fed rough rice and corn required 5.4% more feed than the corn lot. Final conclusions on the value of rough rice compared to corn are given on pages 2 and 14.

TABLE XX. AVERAGE WEIGHTS, GAINS, FEED CONSUMED, AND COST OF GAINS

10 pigs per lot February 2 to April 26, 1940 84 days

LOT NO.	1	2	3
RATION	Corn 90% Protein 9% Mineral 1%	Rough Rice 90% Protein 9% Mineral 1%	Corn 45% Rough Rice 45% Protein 9% Mineral 1%
Average days	75.6	81.2	78.4
Average initial weight, pounds	82.6	81.8	82.5
Average final weight, pounds	233.4	205.1	222.7
Average gain, pounds	150.8	123.3	140.2
Average daily gain, pounds	1.99	1.52	1.79
Total feed per head:			
Corn, pounds	532.35	......	261.05
Rough Rice, pounds	......	522.81	261.05
Shrimp Meal, pounds	24.17	23.70	23.67
Cottonseed Meal, pounds	24.18	23.70	23.67
Alfalfa Meal, pounds	4.89	4.88	4.86
Mineral Supplement, pounds	5.92	5.81	5.80
TOTAL, POUNDS	591.50	580.90	580.10
Average feed per day:			
Corn, pounds	7.04	......	3.33
Rough Rice, pounds	......	6.44	3.33
Shrimp Meal, pounds	.32	.30	.30
Cottonseed Meal, pounds	.32	.30	.30
Alfalfa Meal, pounds	.06	.06	.06
Mineral Supplement, pounds	.08	.07	.07
TOTAL, POUNDS	7.82	7.17	7.39
Feed per 100 pounds gain:			
Corn, pounds	353.01	......	186.19
Rough Rice, pounds	......	424.01	186.19
Shrimp Meal, pounds	16.03	19.22	16.88
Cottonseed Meal, pounds	16.03	19.22	16.88
Alfalfa Meal, pounds	3.24	3.95	3.47
Mineral Supplement, pounds	3.92	4.71	4.14
TOTAL, POUNDS	392.23	471.11	413.75
Cost per 100 pounds gain	$ 6.02	$ 7.14	$ 6.32

COST OF FEEDS: Corn, per ton $30.40; Rough Rice, per ton $30.00; Shrimp Meal, per ton $30.00; Cottonseed Meal, per ton $34.40; Alfalfa Meal, per pound .02¼; Mineral Mixture, per pound .02.

3. The differences in hardness of fat were not great and followed closely the degree of fatness of the different lots. The fat samples from the lot fed rough rice (Lot 2) graded the same as in 1939. The fat from the corn fed lot (Lot 1) graded higher in 1940, while in 1939 the corn lot graded softer than the rice fed hogs. Relative hardness of fat is influenced largely by the total amount of fat put on and also by individual differences in the hogs.

DETERMINATION OF HARDNESS OF FAT

Lot No.	RATION	Average Refractive Index	Estimated Grade on Firmness	Range of Samples
1	Corn	1.4593	Hard	1.4588–1.4598
2	Rough Rice	1.4598	Med. Hard	1.4587–1.4605
3	Corn, Rough Rice	1.4595	Hard	1.4590–1.4602

ANALYSIS OF FEEDS

FEED	Crude Protein	Water	Crude Fiber	Nitrogen Free Extract	Fat	Ash
Ground Rough Rice	7.44	10.27	11.42	63.22	1.37	6.28
Ground Corn	9.13	9.79	2.12	73.51	3.93	1.52
Shrimp Meal	46.75	6.55	14.90	2.44	1.81	27.55
Cottonseed Meal	39.56	7.52	10.31	29.61	6.38	6.62
Alfalfa Meal	14.69	7.13	27.37	39.08	2.02	9.71

EXPERIMENT X

CROSSBRED VS. PUREBRED PIGS

SWEET-POTATO STARCH BYPRODUCT FOR FATTENING SWINE

30% VS. 15% RICE BRAN IN FEEDING MIXTURES

Hogs Used

In three of the lots the hogs used were purebred Duroc-Jerseys, Hampshires, and Poland-Chinas of both sexes. Lot 1 consisted of ten crossbred pigs out of a litter of eleven from a Poland-China sow by a Duroc-Jersey sire. These crossbreds were approximately one week older than the average of the pigs in the other lots.

Sweet-Potato Meal

The sweet-potato meal or sweet-potato starch byproduct was produced at a sweet-potato starch factory in St. Francisville, Louisiana, consisting of the remaining byproduct from sweet-potatoes after the extraction of starch. This meal has a satisfactory texture and odor and appears to be liked by hogs.

THE CROSSBRED LITTER (LOT 1) MADE HIGHER GAINS BUT REQUIRED 7.6% MORE FEED PER 100 POUNDS GAIN

Plan of Experiment

The rations were fed in self-feeders as in previous experiments, the standard mixture being 60% corn, 30% rice bran, and 10% protein mixture. The protein mixture in this test was made up of equal parts of shrimp meal and cottonseed meal. The mineral mixture consisted of 40 parts ground oyster-shell, 40 parts steamed bone meal, and 20 parts salt mixed with the feed at approximately 1% of the ration. In Lot 4, fed sweet-potato meal, the ration was as follows: corn 45%, rice bran 15%, sweet-potato meal 30%, and protein 10%.

In Lots 2 and 3 a comparison was made between two varying amounts of rice bran to determine whether rice bran showed a higher relative value when fed at a 15% level than at the standard 30% level.

CONCLUSIONS

1. The crossbred litter in Lot 1 made higher gains per day than the purebreds fed a similar ration in Lot 2 but required 7.6% more feed per 100 pounds gain. Purebred pigs from strains selected for rapid growth made 5% more rapid gains than the crossbreds.
2. Lot 3 receiving 15% rice bran instead of 30% made slightly higher gains but ate 2.7% more feed per 100 pounds of gain, and the gains were more expensive. The ration was not improved by reducing the amount of rice bran.
3. Lot 4 receiving 30% sweet-potato meal made the highest gains per day but consumed 8% more feed per 100 pounds gain. The pigs

TABLE XXI. Average Feeds, Gains, Feed Consumed, and Cost Per 100 Pounds Gain

10 pigs per lot February 21 to April 10, 1941 48 days

Lot No.	1	2	3	4
Breeding	Crossbred	Purebred	Purebred	Purebred
Rice Bran—percent	30% Rice Bran	30% Rice Bran	15% Rice Bran	15% Rice Bran
Feed Mixtures:				
Corn	60%	60%	75%	45%
Rice Bran	30	30	15	15
Protein Mixture	10	10	10	10
Sweetpotato Meal	..	..	..	30
Average initial weight	159.1	149.3	149.4	150.1
Average final weight	240.5	229.8	229.8	232.4
Average gain	81.4	80.5	81.3	82.3
Average daily gain	1.7	1.68	1.69	1.71
Average Feed per day	9.21	8.41	8.74	9.60
Feed per 100 pounds gain:				
Corn	336.8	311.7	395.8	272.6
Sweetpotato Meal	......	......	......	151.7
Rice Bran	157.3	144.7	72.2	84.4
Shrimp Meal	22.2	20.5	21.1	22.9
Cottonseed Meal	22.2	20.5	21.1	22.9
Mineral Mixture	4.9	4.6	4.7	5.1
Total Feed per 100 pounds gain	543.5	502.0	515.9	559.6
Cost of Feed per 100 pounds gain	$ 7.07	$ 6.52	$ 7.09	$ 7.41

Cost of Feeds: Rice Bran, per ton $18.00; Corn, per ton $28.50; Sweetpotato Meal, per ton $25.00; Cottonseed Meal, per ton $29.00; Shrimp Meal, per ton $38.00.

appeared to relish the sweet-potato meal. With corn at $28.50 per ton and sweet-potato meal at $25.00 per ton, the meal was not as economical as corn.

4. There were no great differences between any of the lots and it is possible that other tests might give different results.

EXPERIMENT XI

PROTEIN SUPPLEMENTS FOR FATTENING SWINE

C. B. Singletary, C. I. Bray, H. A. Davis

Introduction

The principal object of the experiment was to determine the value of soybean oil meal as a protein supplement for swine. The present scarcity of protein supplements of animal origin, such as tankage and shrimp meal, make it necessary to make the greatest use possible of the plant proteins produced in the south. Since experiments with combinations of soybean oil meal and shrimp meal as protein supplements for chickens had shown excellent results, it seemed desirable to test the same feeds for fattening hogs.

Hogs Used

Hogs used in this test were purebred Duroc-Jerseys, Hampshires, and Poland-Chinas from the University herd, uniformly divided between sows and barrows. These pigs weighed approximately 54 pounds at the beginning of the test. This experiment was conducted in cooperation with the Nutrition Laboratory of the College of Agriculture.

Plan of Experiment

The five lots were fed various protein supplements of shrimp meal, cottonseed meal, soybean oil meal, singly and in combination as follows:

Protein Supplement

Lot 1. Shrimp meal.
Lot 2. Cottonseed meal
Lot 3. Soybean oil meal.
Lot 4. Shrimp meal and cottonseed meal.
Lot 5. Shrimp meal and soybean oil meal.

The basic ration consisted of corn meal, 56% to 59%; wheat shorts, 10%; rice bran, 20%, with sufficient protein supplement to make 100%. The feeds had been previously analyzed and the amounts of protein supplement adjusted so as to provide approximately 15% digestible protein in each ration. After eight weeks, the protein content of the rations was reduced to approximately 12%. At the start each lot had some winter oat pasture but as this was entirely gone in eight weeks, 2% of good alfalfa meal was added to the rations.

The corn, wheat shorts, and rice bran were all of good quality and standard grade. The shrimp meal first ordered was too high in salt and a second shipment that was ordered also contained too much salt. For this reason the pigs in Lot 1 on shrimp meal did not do as well as might be expected. The cottonseed meal fed to Lots 2 and 4 was treated with 1% of dry ferrous sulphate to prevent cottonseed meal poisoning. The gossypol content of the cottonseed meal was 1.2% which is high. The soybean oil meal was of good quality.

The chemical analysis of the feeds used showed the following protein content:

Percentage of Protein in Feeds

Corn	9.38%
Rice bran	12.53%
Wheat Shorts	17.81%
Shrimp meal	42.00%
Cottonseed meal	39.39%
Soybean oil meal	46.69%

TABLE XXII. Comparison of Protein Supplements for Fattening Swine

Days on test—December 6, 1941 to March 27, 1942—112 days.

Lot No.	1	2	3	4	5
Protein Supplement	Shrimp Meal	Cottonseed Meal	Soybean Oil Meal	Shrimp Meal Cottonseed Meal	Shrimp Meal Soybean Oil Meal
No. of Pigs per Lot............	9	10	10	10	10
Average Initial Weight..........	53.7	53.7	52.8	54.1	54.0
Average final weight............	214.7	201.4	226.4	223.3	235.5
Average gain....................	161.0	147.7	173.6	169.2	181.5
Average daily gain.............	1.45	1.33	1.56	1.52	1.64
Average Feed consumed:					
Corn........................	400.1	410.0	439.4	435.1	455.2
Wheat Shorts................	64.9	66.9	69.9	70.4	73.2
Rice Bran...................	129.9	133.7	139.8	140.7	146.5
Shrimp Meal.................	46.9	.....	.....	24.5	24.4
Cottonseed Meal.............	.....	49.7	.....	24.5	.....
Soybean Oil Meal............	.....	.....	40.1	.....	24.4
Alfalfa Meal................	7.5	8.4	8.6	8.5	8.7
Total Feed..........	649.3	668.7	698.9	703.6	732.3
Average Daily Feed............	5.80	5.97	6.24	6.28	6.54
Average* Protein Supplement.....	.41	.44	.36	.44	.44
Feed per 100 pounds gain:					
Corn........................	248.5	277.6	253.1	257.1	250.8
Wheat Shorts................	40.3	45.2	40.3	41.6	40.3
Rice Bran...................	80.6	90.5	80.6	83.2	80.6
Shrimp Meal.................	29.1	.....	.....	14.5	13.4
Cottonseed Meal.............	.....	33.6	.....	14.5	.....
Soybean Oil Meal............	.....	.....	23.2	.....	13.4
Alfalfa Meal................	4.7	5.7	5.0	5.0	4.8
Total Feed per 100# gain......	403.2	452.6	402.6	416.0	403.3
Feed Cost per 100# gain.........	$ 6.31	$ 7.01	$ 6.10	$ 6.41	$ 6.21

*Not including alfalfa meal.

The pigs were fed in self-feeders in dry lots. At the close of the experiment, most of the hogs not required for breeding purposes were shipped to Alexandria for slaughter, and fat samples were obtained to test for hardness.

CONCLUSIONS

1. Soybean oil meal fed as the only supplement made the most economical gains and the second largest gains in the test. The meal produced no undesirable effect on the firmness of the fat in the dressed carcasses.

2. A combination of shrimp meal and soybean oil meal was superior to all of the other supplements tested, and gave very satisfactory results as measured by growth of pigs, efficiency of feed utilization, and carcass quality.
3. A combination of shrimp meal with cottonseed meal produced better results than from cottonseed meal or shrimp meal alone but was inferior to the combination of shrimp meal and soybean oil meal or to soybean oil meal alone.
4. When fed as the only supplement cottonseed meal was not as satisfactory as shrimp meal or soybean oil meal in respect to gains or efficient use of feed. One percent of ferrous sulphate mixed with the meal prevented gossypol poisoning.
5. Shrimp meal, when fed as the only protein supplement, did not produce as rapid gains as soybean oil meal. However, this was not a high quality of shrimp meal, containing 12% salt which caused scours and retarded growth when fed at the 15c level.

HOW MUCH PROTEIN SUPPLEMENT TO FEED

As this experiment was designed to test the various protein supplements at high levels, the percentage of protein supplement fed during the first eight weeks varied from 11% soybean oil meal in Lot 3, to 14% cottonseed meal in Lot 2. The reason for feeding different amounts was to make the percentage of digestible protein equal in all lots. During the last eight weeks the protein supplement (including alfalfa meal) was lowered to 4.5% in the soybean oil meal lot, (Lot 3) 5% in Lots 1, 4, and 5, and 5.5% in the cottonseed meal lot, (Lot 2). The pigs continued to do well on the lower level of protein feeding and increased their rate of gain in all lots, as is to be expected. Pigs do not require as much protein during the latter part of the fattening period when they are gaining most rapidly.

It has usually been recommended that at least 10% protein supplement be fed pigs weighing 50 to 100 pounds, and 6% to 7% supplement for fattening hogs from 125 pounds to 225 pounds. At the present time (1943) it will undoubtedly be necessary, on account of scarcity of these feeds, to feed less protein concentrates than usual. It will at least be necessary to get along with less of the animal proteins such as tankage or shrimp meal, and make up the balance with the vegetable protein feeds such as soybean oil meal, peanut oil meal and cottonseed meal. By making greater use of pastures, or by using some of the legume hay meals of good quality, it will be possible to make up well balanced rations without using more than 5% of the commercial protein feeds.

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SOYBEAN PRODUCTION IN THE LOUISIANA–MISSISSIPPI DELTA AREA

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SOYBEAN PRODUCTION IN THE LOUISIANA–MISSISSIPPI DELTA AREA

by FRANK D. BARLOW, JR.

INTRODUCTION

The South has been called upon to make substantial increases in the production of vegetable oils to help meet wartime requirements. The three vegetable oil crops which can be expanded in the Southern States are cotton, soybeans, and peanuts. In appraising the alternative possibilities of war crops, it is important to determine to what extent the expansion of soybeans and peanuts should proceed in various areas in order to maximize total war production.[1]

The national goal for soybean production in 1943 was set at 10,500,000 acres, or 3 per cent less than the 1942 acreage. In the Southern States, however, the production goal of 910,000 acres represents a 20 per cent increase over the 1942 acreage. In Louisiana where considerable land is suited to soybean production, the suggested minimum 1943 soybean for beans goal was set at 130,000 acres, or 53 per cent more than the 1942 acreage.

Farmers growing soybeans of the yellow varieties in 1943 have been assured of a price of $1.80 per bushel by the United States Department of Agriculture.[2] With the uncertainty of price removed, the profitableness of soybeans in comparison with other competing crops depends primarily upon the success of individual farmers in obtaining good soybean yields.

The fundamental objectives of this study are: (1) to appraise the soybean production expansion from the standpoint of sound farm management on the individual farm; (2) to provide a broader perspective of the price structure necessary for directing the use of agricultural resources to the production of essential war materials; and (3) to determine the extent that soybeans should be increased versus the possible increase or decrease in cotton or feed crops which will result in the maximum agricultural production of the area.

Detailed information was obtained from 25 delta plantations in Concordia Parish to serve as a basis for evaluating the soybean enterprise as a wartime crop. Concordia Parish was selected because approximately 17 per cent of the 1942 soybean acreage reported for the Louisiana Mississippi Delta Area was grown in that parish, and the acreage planted to soybeans in Concordia Parish represented approximately 9.1 per cent of the total cropland, as compared with 4.5 per cent in Madison, 3.1 per cent in Tensas, and 3.0 per cent in East Carroll. The soybean acreage in the remaining parishes of the area was less than 3.0 per cent of the total cropland.[3]

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[1] Possibilities of expanding peanut production in the North Louisiana Upland Cotton Area have been appraised in Louisiana Experiment Station Bulletin 361, "Peanuts as a Wartime Crop in Louisiana."

[2] Moisture content must not be over 14 per cent.

It is believed that the data obtained in Concordia Parish are representative of the Louisiana Mississippi Delta Area. The general conclusions are thought to be partially applicable to the Red River Bottom and Upland Area and to parts of the Central Louisiana Mixed Farming Area, (see Figure 1). The conclusions in general are based upon the usual plantation organization found in the delta areas of the State and are not intended to fit each and every special case.

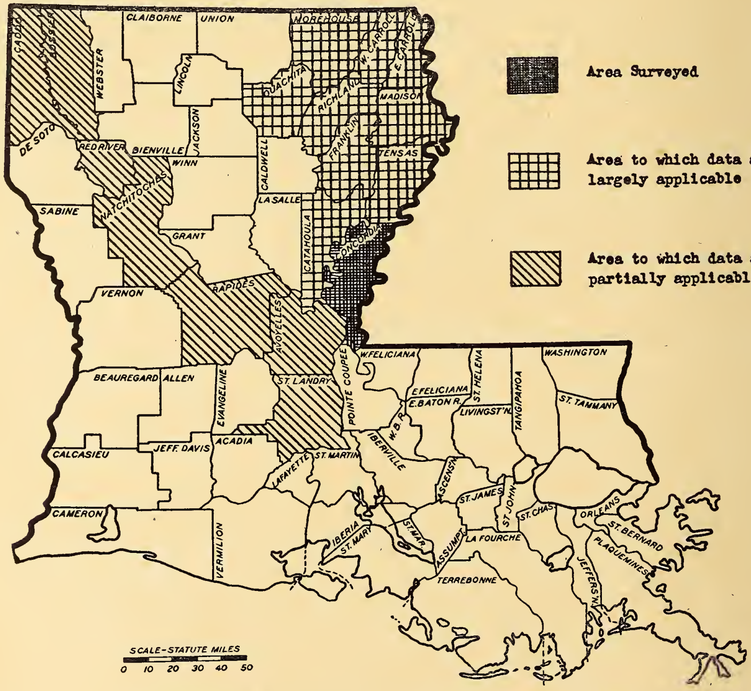

FIGURE I. Location of Delta Soybean Areas

Soybeans Versus Cotton for Oil and Meal Production

The relative yields of oil and meal from soybeans and cottonseed per unit of resources is an important consideration in appraising how far soybean production should be expanded.

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[3] Based upon data obtained from the Agricultural Adjustment Administration.

Oil and meal yields per acre: When national average yields are used, soybeans yield 135 per cent more oil and 343 per cent more meal per acre than does cotton (Table 1).

TARLE 1.—The yield per acre of oil and meal from cottonseed and soybeans compared, Louisiana and United States[1]

	Average yield per acre[2]	Oil produced per acre	Meal produced per acre	Oil per 100 lbs. seed[2]	Meal per 10 lbs. seed[2]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Louisiana-Mississippi Delta Area					
Cottonseed	634.0[3]	101.4	277.7	16.0	43.8
Soybeans	810.0[3]	81.0	688.5	10.0	85.0
Louisiana State Average					
Cottonseed	460.0[4]	73.6	201.5	16.0	43.8
Soybeans	768.0[4]	76.8	652.8	10.0	85.0
United States					
Cottonseed	458.0[4]	71.9	206.1	15.7	45.0
Soybeans	1140.0[4]	168.7	912.0	14.8	80.0

[1] Parishes included in the Louisiana Mississippi Delta Area are as follows: East Carroll, Madison, Tensas, Concordia, West Carroll, Morehouse, Ouachita, Richland, Franklin, and Catahoula.

[2] *The Fats and Oils Situation*, March, 1943, Bureau of Agricultural Economics, United States Department of Agriculture, p. 14.

[3] Simple average yields obtained from the Agricultural Adjustment Administration—cotton 1937-41, soybeans 1942.

[4] Average yields 1938-42.

National averages, however, are not applicable to Louisiana or to the other principal cotton States, because soybean yields are considerably higher in the main soybean producing area of the North Central States than in most Southern States. The 1937-41 average yield of soybeans was 19.4 bushels an acre in the North Central States, as compared with 10.5 bushels an acre in the 10 important cotton growing States. The yields of oil per 100 pounds of beans is also somewhat lower in the Southern States than in the Northern soybean areas. The lower proportion of oil recovered from soybeans grown in the Southern States is due principally to the fact that the use of hydraulic compressors in the South results in recovery of a lower percentage of oil than does the solvent process or expeller type press used in the Northern areas.[4]

In Louisiana, on the basis of state average yields, soybeans provide only 4 per cent more oil and over three times as much meal per acre as cotton. The oil recovered per 100 pounds of beans is only 10 pounds, which is low in comparison with the national average of 14.8 pounds.

Soybean and cotton yields vary greatly from area to area in Louisiana. In the Louisiana Mississippi Delta Area, where cotton yields are high, 25 per cent more oil is recovered per acre from cottonseed than from soybeans. Soybeans, however, yield a very high proportion of meal per 100 pounds of beans, and the production of soybean meal, an important protein supplement, is 688.5 pounds per acre, as compared with 277.7 pounds of cottonseed meal.[5]

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[4] *The Fats and Oils Situation*, March, 1943, Bureau of Agricultural Economics, U.S.D.A.

Oil and meal yields per man hour: The relative production of oil and meal from soybeans and cottonseed per man hour of labor are compared for the Louisiana Mississippi Delta Area in Table 2. Cotton is a labor intensive crop in direct contrast to soybeans. The determination of the degree to which it would be wise to increase soybeans at the expense of cotton is complicated by the amount and type of available labor and machinery, and the relative needs for long staple cotton versus vegetable oil and oil meals. The wide variation in the hours of man labor required to produce an acre of soybeans in comparison with cotton, together with the fact that cottonseed in delta areas is only a by-product of long staple cotton, limits the significance of the relative output of oil and meal from soybeans and cottonseed per hour of man labor. Nevertheless, the production of oil and meal per hour of man labor is much higher for soybeans than for cotton.

TABLE 2.—Production of oil and meal from cottonseed and soybeans per man hour of labor compared, Louisiana Mississippi Delta Area

CROP	Man hours required per acre	OIL YIELD		MEAL YIELD	
		per acre	per man hr.	per acre	per man hr.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Cottonseed	183.6	101.4	.6	277.7	1.5
Soybeans	9.8[1]	81.0	8.3	688.5	70.2

[1] Adjusted to a 13.5 bushel per acre yield.

Labor, Power, and Equipment Requirements[6]

Man labor requirements for cotton production are considerably higher than for the other major crops. The production of cotton, however, utilizes a much lower grade of labor than does the production of soybeans, oats, or corn, the production of which is highly mechanized, (Table 3).

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[5] Two other products from cottonseed have not been included here, namely, cottonseed hulls and linters, which also are being used for essential war purposes.

[6] Labor and power requirements presented must not be interpreted as being applicable to all farms in the Louisiana Mississippi Delta Area. The plantation organizations studied were highly mechanized. Labor and power requirements presented apply only to the plantation operator's independent crop.

TABLE 3.—The proportion of skilled and common farm labor required in the production of soybeans, oats, corn, and cotton, Louisiana Mississippi Delta Area

CROP	LABOR CLASSED AS		Total labor required
	Skilled[1]	Common[2]	
	Hours	*Hours*	*Hours*
Soybeans	9.6	0.0	9.6
Oats	7.1	0.0	7.1
Corn	13.6	4.3	17.9
Cotton	13.0	170.6	183.6

[1] Skilled labor includes all man labor required for the operation of the highly mechanized farm equipment used in the production of the crop.

[2] Common labor includes all other labor necessary, which is usually done by the family labor—Women, old men, and children. Practically all hoeing and cotton picking can be done by family workers.

Soybean and oat production is completely mechanized, and practically all labor required must be skilled in the use of mechanized equipment. Corn production which is mechanized also requires skilled farm labor, except for hoeing. Cotton is the main crop which utilizes the family labor supply. Hoeing and picking do not require highly skilled workers and can be done by older men, women and children. The average man labor requirements for producing an acre of cotton in the Louisiana Mississippi Delta Area are 183.6 hours; an acre of corn, 17.9 hours; an acre of soybeans, 9.6 hours; and an acre of oats, 7.1 hours. Tractor, mule, and combine requirements for these crops are given in Tables 1, 2, 3, and 4 in the Appendix.

Wages paid to farm laborers vary widely, depending upon certain non-monetary factors, such as the furnishing of a house to live in, a garden plot, and in many cases a small acreage of free rent land. Cash wages vary from $1.00 a day to $3.00, depending upon the nature of the work, but the average daily rate for a good farm hand, excluding hoeing and cotton picking, is about $1.50 in cash. Wages of tractor drivers averaged about $1.45 in 1942 and nearly $1.75 in the spring of 1943.

The average cost of operating a tractor is estimated to be $5.98 per 10-hour day, or $0.598 per hour of use, (Appendix Table 5). These data are an average for all tractors and no detailed breakdown was made by type and size of tractors. Most tractors in the area are standard 4-row tractors, usually the John Deere or the International. Because of the heavy soils and irregular fields in the Louisiana Mississippi Delta, 2-row equipment is commonly used for the standard 4-row tractor.

The cost of operating a combine is estimated to be $1.29 an acre for soybeans and $1.06 an acre for oats, (Appendix Table 6).

The average annual cost of operating tractor equipment per acre is estimated to be $0.86 for soybeans, $0.67 for oats, $0.60 for corn, and $0.99 for cotton, (Appendix Table 7).

Soybean Production in 1942

The Louisiana Mississippi Delta Area is potentially the most important soybean area of the state from the standpoint of commercial production for oil, producing approximately 36 per cent of the total State acreage in 1942. The acreage of soybeans grown alone is large in the Central Louisiana Mixed Farming Area, production being concentrated in Avoyelles and St. Landry Parishes, but the majority of beans grown in this area were of the Avoyelles variety, which is principally a hay bean.[7]

The 1942 experience with soybeans in the Louisiana Mississippi Delta Area was not favorable, but this, in itself, does not afford a fair test for the enterprise as a war crop. Commercial production of soybeans for beans is relatively new, and farmers encountered many production obstacles in 1942, the most important of which were: choice of a good oil variety bean that was adapted to Louisiana conditions, inadequate knowledge of methods and rates of seeding and general cultural requirements, and, finally, an abnormally unfavorable growing season for soybean production.

Net enterprise returns per acre from soybeans: Yield per acre is the most important factor determining the profitableness of the soybean enterprise with the uncertainty of price removed. The yields reported in the Louisiana Mississippi Delta Area ranged from 9 to 17 bushels an acre in 1942. On the farms studied in Concordia Parish, the average per acre yield was 11.0 bushels, and most farmers received $1.60 a bushel for the beans at the farm. The gross value per acre was $17.60. Operating expenses, which include all cash and equipment costs, amounted to $10.22, which left $7.38 as the net enterprise return per acre, or the amount left for allocation to land and management, (Table 4).

These data are for large operating farm units and do not reflect the true cost situation for the small farmer who does not own a combine. The most usual arrangement for custom combining was one-half the beans for harvesting. With a production of 11 bushels of beans an acre where beans were harvested on the customary one-half basis, the operating expenses would have been $16.18 an acre, leaving a net return of $1.42 an acre.

Net enterprise returns from soybeans compared with oats, corn, and cotton: In pre-war years when soybean production was a minor enterprise, it was not important to make a careful allocation of costs, providing the crop increased total farm earnings. After two years of war when farmers are faced with material shortages of labor and machinery, the choice of alternatives is of extreme importance. This is particularly

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[7] The intended acreage of soybeans for beans for 1943, according to tabulations from the 1943 AAA farm plan sheets, is estimated to be 65,636 acres in the Louisiana Mississippi Delta Area, 58,326 acres in the Central Louisiana Mixed Farming Area, and 26,212 acres in the Red River Bottom and Upland Area. These three areas account for approximately 91 per cent of the total state intended acreage for 1943.

TABLE 4.—Gross value, operating expenses, and net enterprise return per acre for soybeans, Louisiana Mississippi Delta Area, 1942[1]

ITEM	Unit	Price per unit	AVERAGE ALL FARMS	
			Quantity	Value
		Dollars		*Dollars*
Gross Value				
Beans	Bushel	1.600	11.0	$ 17.60
Operating Expenses[2]				
Seed[3]	Bushel	2.300	1.0	2.30
Labor	Hours	0.150	9.6	1.44
Tractor	Hours	0.598	6.5	3.89
Combine[4]	Per acre	1.290	....	1.29
Other machinery[5]	Per acre	0.860	....	0.86
Truck expense	Per acre	.....	....	0.32
Mule work	Hours	0.15	0.8	0.12
TOTAL				$ 10.22
New Enterprise Return[6]				$ 7.38

[1] Average 25 plantations, Concordia Parish. Soybeans grown by the operator with hired labor—mechanized.

[2] General farm overhead costs for land and management are excluded.

[3] Cash or cash equivalent.

[4] The annual average cost per acre of operating a combine includes a charge for repairs, depreciation and interest.

[5] The annual average cost per acre of operating mechanized equipment includes a charge for repairs, depreciation and interest.

[6] Net enterprise return is the gross value of the beans less the specified operating expenses. This is the amount which may be allocated to general overhead and mangement.

true when the increase of soybeans is likely to result in the decrease of other crops. Further expansion of soybean production will not likely be in competition with cotton but with feed crops for the use of land, labor, equipment, and management.

The gross cash values, operating expenses, and net enterprise returns per acre from soybeans, oats, corn, and cotton are compared in Table 5. The average net enterprise returns from soybeans, excluding the charge for land and management was $7.38, which is considerably lower than for other crops. The return per acre is only part of the picture and becomes of limited significance where labor is scarce, because more acres of soybeans or oats can be produced with a given labor supply than corn or cotton.

Net enterprise returns per hour of work: Another measure of the relative profitableness of alternatives is the relative returns per hour of man labor. The ratio of returns to man hours of work is highest for oats, the crop requiring the least man labor to grow and harvest (Table 6). Corn ranks second, when judged on this basis; soybeans, third; cotton, fourth. It is recognized, of course, that such a ratio is not absolutely accurate in itself, because certain charges for land and management have not been made; but when the enterprises are compared in this way, it does show

TABLE 5.—Gross cash values, operating expenses, and net enterprise returns per acre for soybeans, oats, corn and cotton compared, Louisiana Mississippi Delta Area, 1942[1]

ITEM	Cotton	Corn	Oats	Soybeans
Yield per Acre	Lint 541 lbs. Seed 1049 lbs.	24.0 bu.	42.0 bu.	11.0 bu.
Average Price	Lint 19.5c lb. Seed $47.00 ton	$1.00 bu.	$ .60 bu.	$1.60 bu.
Gross Cash Value	$ 130.15	$24.00	$25.20	$17.60
Operating Expenses[2]				
Seed[3]	$ 1.60	$ 0.34	$ 2.56	$ 2.30
Legume seed	2.03	......	......	......
Fertilizer	1.56	0.54	0.74	......
Labor	8.31[4]	2.67	1.06	1.44
Cotton picking[5]	15.90	......	......	......
Sacks	1.08	......	......	......
Poison	1.23	......	......	......
Ginning	5.56	......	......	......
Tractor	4.66	2.93	2.57	3.89
Combine	....	......	1.06	1.29
Other machinery[6]	0.99	0.60	0.67	0.86
Truck expense[7]	1.06	......	0.40	0.32
Mule work	0.42	0.85	0.15	0.12
TOTAL	$ 44.40	$ 7.93	$ 9.21	$10.22
Net Enterprise Returns[8]	$ 85.75	$16.07	$15.99	$ 7.38

[1] Average 25 plantations, Concordia Parish. Crops worked independently by the operator with hired labor—mechanized.

[2] General farm overhead costs for land and management are excluded from specified operating expenses.

[3] Cash or cash equivalent.

[4] Labor for cotton picking is excluded.

[5] Average rate for cotton picking is assumed to be $1.00 per 100 pounds. The range in rate was from $0.90 to $1.25 per 100 pounds.

[6] The annual average cost per acre of operating mechanized equipment included a charge for repairs, depreciation, and interest.

[7] Cash or cash equivalent.

[8] Gross cash value less the specified operating expenses. This is the amount available to the operator for allocation to other productive resources.

that their relative profitableness in terms of man labor is different from the per acre of land picture.

Cultural practices: Cultural practices vary from farm to farm, but in the main, soybeans were planted and cultivated similar to corn and cotton. Usually, soybeans were planted on the poorly drained land and land infested with weeds and grass. Because of this, it is hard to make accurate comparisons of net enterprise returns per acre from soybeans with other crops which are grown on a better grade of land. Almost all soybeans grown alone for beans in the delta are grown on the larger farm units or plantations which have become highly mechanized, and soybean production lends itself to complete mechanization from the time of land preparation to the harvesting of beans.

TABLE 6.—The net enterprise returns per hour of work for soybeans, oats, corn, and cotton, 1942[1]

CROP	Man hours per acre	Net enterprise returns[2]	Net enterprise returns per man hour
	Hours	*Dollars*	*Dollars*
Soybeans	9.6	8.72	.91
Oats	7.1	16.95	2.38
Corn	17.9	18.74	1.05
Cotton	183.6	109.96	.60

[1] Average yields obtained from survey made of 25 plantations in Concordia Parish, 1942.

[2] The charge for labor is excluded from operating expenses as well as the charge for land and management.

Because of standard planting and cultivating equipment for cotton and corn, nearly all soybeans were planted in 38-inch rows. Higher yields and, possibly, better weed control could be obtained on narrow rows of 20 to 24 inches. Usually, farmers did not hoe soybeans, but in a few exceptional cases hoeing was done. Where hoeing was practiced, it was thought helpful in that yields were increased and harvesting facilitated.

Most harvesting was done with 6-foot combines, very few combines having the motor attachment. The rate of harvesting beans with a 6-foot combine was estimated to be about 7 acres per 7 hour day, as compared with about 14 acres of oats in a 10-hour day. Harvesting soybeans is much slower than harvesting oats, mainly because the land is rougher and because of the rank weed growth. It is difficult to estimate the probable acreage that can be harvested per combine in this area, because fall rains limit the length of the harvesting season for soybeans, which begins in October and ends sometimes in November.

Seeding rates vary, but the most usual rate was one bushel, or 60 pounds an acre. Many growers who were planting soybeans for beans for the first time tended to seed too lightly, 20 to 30 pounds an acre. For the best yield at least 60 pounds an acre should be planted.

Some farmers recommend early planting from March 15 to April 15, and others prefer late beans, planted in May and early June. The advantage in planting early is that early planting of beans will not be in direct conflict with cotton planting in April.

Varieties: The most common varieties of oil beans planted in 1942 were Mamloxi, Macoupin, and Arksoy. The Avoyelles bean, which is primarily a hay bean, was planted for seed and in some cases for oil. This bean frequently was planted for oil purposes because seed of suitable oil varieties was not available.

On the plantations surveyed in Concordia Parish approximately 48 per cent of the beans planted in 1942 were Mamloxi; 21 per cent, Arksoy; 18 per cent Avoyelles; and 13 per cent, all other varieties. The

Macoupin and Arksoy were grown more generally in the northern parts of the area. The Ogden bean is relatively new in the area, and the brief experience with it is highly favorable.[8]

The Ogden, Mamloxi, and Macoupin are varieties generally preferred by farmers in 1943. The Arksoy and Macoupin are early maturing varieties which are ready for combining before frost. The Mamloxi does not combine well until after frost. In the Louisiana Delta Area there are advantages and disadvantages of early and late maturing varieties, depending upon the weather. Early maturing varieties do not combine well where there is abnormal weed and green grass growth which will choke the combine, and if left too long, shattering will result in reduced yields. Late maturing varieties are ready to be harvested after the first frost. After frost the grass is killed, thus facilitating combining, as a certain amount of dead grass going through the combine is beneficial in that less beans are cracked or split. Depending upon the late fall rains, late combining of beans in the delta is hazardous. After the fall rains it is practically impossible to combine soybeans, and complete abandonment is not unusual.

Soybeans as an Alternative on Delta Plantations

Soybeans have been grown extensively in the Louisiana Mississippi Delta Area since the early 30's as a hay crop and to be turned under for soil building purposes. Harvesting beans for commercial purposes was not important, except on a small scale for planting seed, until 1941. High wartime prices for soybeans are responsible for the increased production of soybeans for oil.

Under the AAA program which curtailed cotton production, delta farm operators have been searching for a suitable cash crop alternative and one which would be complementary in the cropping system. Soybean production fits well in the crop organization of delta plantations. As a cash war crop, delta operators have found soybeans profitable because it has provided utilization of previously unutilized resources, particularly land and equipment.

Soybeans in the Louisiana Mississippi Delta usually have been planted on the poorest land, land poorly drained, or recently cleared. Even when the beans are harvested, the soil is improved by the addition of organic matter and nitrogen as well as by improved soil tilth. In many cases, soybeans and corn are rotated successfully.

Estimated returns from soybeans, oats, and corn: Net returns vary with yields and with prices. A comparison of estimated net enterprise returns from these crops at different yields and at different prices will assist in appraising the economic position of each in profitable crop combinations. These estimates are presented in Table 7.

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[8] The Northeast Louisiana Experiment Station's preliminary experiments in the soybean variety test indicate that the Ogden bean has been the highest yielding variety. The 1-year average yield is reported to be 40 bushels an acre, nearly twice that of the next highest yielding variety, which was the Arksoy with a 2-year average yield of 22.7 bushels an acre.

Let us suppose that it is desired to compare relative returns from soybeans, with a yield of 15 bushels an acre and selling at $1.80 a bushel, to

TABLE 7.—Estimated net returns per acre and per hour of man labor from soybeans, oats and corn with different yields and prices, Louisiana Mississippi Delta Area[1]

Price per bu.	SOYBEAN YIELDS PER ACRE									
	7 bushels		11 bushels		15 bushels		19 bushels		23 bushels	
Dollars	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*
1.50	$ .78	$ .24	$ 6.28	$ .80	$ 12.21	$ 1.40	$ 18.11	$ 1.93	$ 24.05	$ 2.44
1.60	1.48	.32	7.38	.92	13.71	1.55	20.01	2.11	26.35	2.66
1.70	2.18	.40	8.48	1.03	15.21	1.70	21.91	2.30	28.65	2.88
1.80	2.88	.48	9.58	1.15	16.71	1.86	23.81	2.48	30.95	3.10
1.90	3.58	.56	10.68	1.26	18.21	2.01	25.71	2.67	33.25	3.32

Price per bu.	OAT YIELDS PER ACRE									
	26 bushels		34 bushels		42 bushels		50 bushels		58 bushels	
Dollars	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*
.40	$ 2.12	$ .46	$ 4.90	$ .85	$ 7.59	$ 1.22	$ 10.33	$ 1.55	$ 13.01	$ 1.84
.50	4.72	.84	8.30	1.34	11.79	1.81	15.33	2.22	18.81	2.59
.60	7.32	1.23	11.70	1.82	15.99	2.40	20.33	2.90	24.61	3.35
.70	9.92	1.61	15.10	2.31	20.19	2.99	25.33	3.57	30.41	4.10
.80	12.52	1.99	18.50	2.79	24.39	3.58	30.33	4.25	36.21	4.85

Price per bu.	CORN YIELDS PER ACRE									
	12 bushels		18 bushels		24 bushels		30 bushels		36 bushels	
Dollars	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*	*Per acre*	*Per hour*
.70	$ 2.40	$ .32	$ 5.92	$ .52	$ 8.87	$ .65	$11.90	$ .72	$ 15.15	$ .76
.85	4.20	.45	8.62	.70	12.47	.85	16.40	.94	20.55	.98
1.00	6.00	.58	11.32	.87	16.07	1.05	20.90	1.15	25.95	1.19
1.15	7.80	.71	14.02	1.04	19.67	1.25	25.40	1.37	31.35	1.41
1.30	9.60	.84	16.72	1.21	23.27	1.46	29.90	1.59	36.75	1.63

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[1] The estimated net returns per acre and per man hour of work are only a relative measure of the profitableness of the enterprises. The cost of land and rent and certain other farm overhead costs have not been accounted for, and it has been assumed that these costs would be approximately the same for each particular enterprise. The returns per acre represent the net amount available for land rent and certain other farm overhead costs not specified in Table 5. The returns per man hour are a relative measure of profitableness and represent the net amount available per man hour of work for the payment of wages, the cost of land rent and the other farm overhead costs not specified, and do not represent the actual monetary return to labor.

oats, with a yield of 42 bushels and selling at $0.60 a bushel. Reading down the column from the soybean yield of 15 bushels, a return of $16.71 an acre is estimated. In like manner, for oats, a return of $15.99 an acre is estimated. With these yields and expected prices the returns per acre from soybeans and oats are nearly equal. The ratio of returns to hours of work can be compared for soybeans, oats, and corn in the above illustration for different yield and price situations. When the soybean yield is 15 bushels and beans sell for $1.80 a bushel, and the oat yield is 42 bushels and oats sell for $0.60, the relative returns per hour are only $1.86 for soybeans, as compared with $2.40 for oats, even though the per acre returns are almost equal. The fact that labor requirements for growing an acre of oats is only 7.1 hours, as compared with 9.8 for soybeans yielding 15 bushels, is responsible for the relatively higher returns per man hour of work.

Similar comparisons can be made for other yield and price situations for soybeans, oats, and for corn, and conclusions similar to the following can be made:

1. Soybeans yielding 15 bushels an acre and selling for $1.80 a bushel are usually more profitable than oats yielding 42 bushels an acre and selling for $0.50 a bushel. The per acre returns are $16.71 for soybeans and $11.79 for oats, while the relative returns per man hour are $1.86 for soybeans and $1.81 for oats.

2. The per acre returns of soybeans in the above case are slightly above the $16.07 for corn when the yield is 24 bushels and the price is $1.00 a bushel. The relative return per man hour, however, is lower for corn than for soybeans, because of higher labor requirements for corn as compared with soybeans.

Income possibilities: Soybeans offer promising income possibilities at the guaranteed support price of $1.80 a bushel, provided yields of 15 bushels an acre or over can be obtained. Soybean production will be as profitable, and in some cases more profitable, than oats and corn with yields of 42 bushels and 24 bushels, respectively, when the price of oats is $0.50 and that of corn is $1.00.[9]

Competition for the use of man labor and equipment: In recent years the delta plantations have become highly mechanized. Soybean production is well adapted to the use of mechanized equipment. The soybean enterprise is complementary to the cotton enterprise and competition for the use of labor at harvest time is limited, Table 8, mainly because labor requirements for harvesting an acre of beans are small in comparison with cotton and also because a different type of labor is necessary. Cotton picking is usually done by women, children, and old people.

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[9] Whether or not it is desirable to grow soybeans instead of oats or corn depends upon the general type of farm. Many delta plantations have large livestock enterprises, principally beef cattle and hogs, or beef cattle or hogs. Where the crop organization is balanced with livestock enterprises, it is doubtful if expanded soybean production which entailed reduction in feed crops would be practical, because of the minimum feed requirements; however livestock farms are in a better position to salvage the soybean crop in case the harvesting season is unfavorable for harvesting and abandonment is high.

On those plantations where there are no livestock, soybeans with yields of 15 bushels an acre or over afford a very profitable cash crop alternative to feed crops and particularly to corn where corn yields are below average and with existing price relationships.

There is no conflict with oats for the use of labor, power, and equipment. In fact, soybeans are supplementary to the oat enterprise in that combines can be more fully utilized, thus reducing the per acre costs of maintaining a combine for harvesting.

As for soybeans and corn, there is conflict in labor, power, and equipment requirements, and the crops are competitive in this respect. The conflict is not serious, however, either during the growing of the crop or harvest, because requirements per acre are not great and in a balanced cropping system seldom more than 40 per cent of the total cropland is planted to these two crops.

TABLE 8.—Distribution of man labor by specified crops, per acre, Louisiana Mississippi Delta Area, 1942[1]

	HOURS PER ACRE			
	Soybeans	Oats	Corn	Cotton
January	....	....	....	....
February	.3	....	.3	....
March	1.9	.1	1.3	.6
April	1.1	1.0	2.5	2.5
May	.8	2.4	3.2	23.9
June	.4	.2	1.3	21.9
July	....	.8	....	1.9
August	....	1.5	....	13.1
September	....	.6	....	52.4
October	1.5	.5	4.1	52.7
November	3.1	....	4.8	14.2
December	.5	....	.4	.4
TOTAL	9.6	7.1	17.9	183.6

[1] Data obtained from 25 plantations, Concordia Parish.

Production possibilities as a war crop: The most efficient wartime use of productive resources can be achieved by producing those crops that obtain full and efficient utilization of the given resources and those most seriously needed in the war effort. Soybeans and long staple cotton are the two main war crops that are grown in the Louisiana Mississippi Delta Area.

Livestock production is a major enterprise on many plantations and the success of beef production is dependent upon the complementary production of feed crops—corn, oats, and hay. To appraise the extent to which it is desirable or economically practical to expand soybean production, it is essential to recognize the effects of increasing soybeans on different size and type groups of farms; for example, a farm operator who has developed a beef cattle enterprise must plant enough cropland to feed crops to meet minimum feed requirements. Soybean production in this situation is definitely rated as a third alternative to cotton and feed crops.

There are many delta plantations, however, where livestock enterprises have not been developed. It is on these plantations that relatively large increases in soybean production can be made. Increased soybean production on these farms under expected price relationships can be expected to be as profitable, and in some cases more profitable, in comparison to corn and oats and other feed crops, and is a means of securing the efficient and most complete use of available farm resources.[10]

In contrast to the two major type groups of farm organizations prevalent on delta plantations, there are the small delta farms, where successful soybean production is questionable, regardless of type of farm. Soybean production on small delta farms should not be attempted at all, unless the farm is mechanized, the use of a combine is assured, and sufficient cropland is readily available.

Increasing soybean production on the individual farm: Production possibilities have been discussed for the major size and type groups of farms and it was concluded that: the largest increase should come from delta plantations that do not have a large livestock enterprise; that increasing production on crop and livestock organizations is secondary to cotton and feed crops; and that only in exceptional cases will the production on small farms—either crop or crop and livestock—be economically feasible. It is important to determine how many acres of soybeans can be grown on the representative farm, which will maximize the total productive contribution to the war effort in each of the above situations.

Cotton, without question, is the basic crop on all delta plantations. Its production is intensive and utilizes family labor that would not be fully utilized if cotton acreage were maintained or further curtailed. The major portion of this labor supply would not be suitable or employable in the production of soybeans and oats. Under these circumstances it is concluded that cotton acreage restrictions should be relaxed in the area. The fact that practically 100 per cent of delta cotton is long staple, an inch or better, it is believed that acreage increases of cotton on many small delta farms is the best possible wartime use of farm resources where the labor supply is adequate. The cotton acreage on the individual farm should be so adjusted as to secure the full employment of family workers on farms, as well as those in the nearby towns, during peak seasons.

Assuming that resources are being utilized wisely when the full cotton allotment is planted, or when sufficient cotton is planted to furnish full employment for family workers, it is then necessary to consider comparative advantages of soybeans versus feed crops.

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[10] It has been recognized that soybeans in the delta are a hazardous crop, mainly due to weather conditions during the harvest season. If it is necessary to abandon the crop, grazing the bean field with cattle or hogs is about the only way for salvage. This fact does become an important consideration when there are no livestock on the farm. On the other hand, it would be unwise for livestock farms to expand soybean acreage at the expense of feed crops, if soybeans were to be considered as complementary to the livestock enterprise.

The delta plantations without a livestock enterprise must produce enough corn, oats, and other feed to provide for the minimum needs of workstock and small numbers of other livestock. This will vary with the needs of each individual farm. To determine how many acres of soybeans this type of farm should grow depends upon the probable yields and prices of corn, oats, and soybeans. If the corn yield is expected to be less than 24 bushels an acre, the oat yield less than 42, and the soybean yield 15 bushels or more, it is reasonable to conclude that the substitution of soybeans for corn and oats would be economically profitable with expected price relationships of $1.80 for soybeans, $0.50 for oats, and $1.00 for corn. Under these conditions, after planting enough cotton to utilize the family labor fully and sufficient feed to meet essential needs, it will be profitable to plant the remaining cropland in soybeans.

On plantations where the cropping system is supplemented with a livestock enterprise, the choice of soybeans ranks third after cotton and feed crops. Even though the margin of profitableness may be in favor of soybeans over corn and oats as the enterprises individually are concerned, it is unlikely that decreasing corn and oats would be a desirable alternative to the complementary relationship of these crops and livestock. It is also doubtful that the substitution of soybeans for feed crops in this case would result in more efficient food production per unit of resources.

Small farms generally will find the production of soybeans unprofitable as well as impracticable. Some small farmers, moved by patriotism, accepted soybean goals for 1943. The practice of granting goals to these farms, when it was evident that custom combining would not be available at a reasonable charge, was very unwise and will result in dissatisfaction at harvest time. In 1943, because of the high labor cost and the limited number of combines, it will be impractical to harvest beans in small plots of 3 to 6 acres, either for the combine operator or for the individual farmer. Most small farmers could choose a better alternative for the use of their labor, land, and equipment.

Conditions Necessary for Successful Soybean Production

The 1942 experience with the soybean enterprise indicates that physical requirements as well as monetary costs are about the same whether the yield is high or low. With prices guaranteed at $1.80 a bushel, the profitableness of soybean production will depend primarily upon the yield of beans. This fact supports the contention that, for successful production, the enterprise should not be considered as a sideline. Practical farmers in the area contend that the soybean enterprise is the best alternative for making full wartime utilization of the soil resources after the cotton acreage has been determined and minimum feed requirements have been met. An analysis of the 1942 production situation on delta plantations, based upon the results obtained in Concordia Parish, indicate that soybean production is the best crop for effectively utilizing the remaining farm resources after cotton and the major feed crops acreages were determined.

Suggestions made for successful production must of necessity be realistic and apply to the production situation as it actually exists. Because of climatic conditions and the hazards of late fall harvesting, it would be unwise to plant soybeans on the best delta soils.[11] There is a definite place for soybean production in the Louisiana Mississippi Delta Area, but it is doubtful that total wartime production from the area would be maximized by shifting soybean production to the best soils. The recommendations that follow are limited to those that are possible to achieve in the present situation and were suggested by the farmers who grew soybeans most successfully in 1942.

1. Thorough preparation of the land is essential. Recognizing that the soybean land is inferior to the best cotton land, it is doubly important that the land be plowed in the fall. Land plowed in the fall will make spring preparation easier and the seed bed better.

2. To reduce the conflict in labor requirements, early spring planting about the last of March, the same as for corn, is satisfactory. If there is no serious conflict with other farm work, April or May plantings are most satisfactory.

3. Soybeans should be planted in rows to permit cultivation. The rows should be as close as cultivating equipment will permit, thus increasing yields and effective weed control.

4. The choice of a good oil variety which will give high yields is very important. Where the land is not infested with weeds and grass, early maturing varieties are preferable, because the beans can be harvested before the fall rains, thus reducing the possibility of abandonment. In most of the delta, however, it is difficult to control weeds and grass, and where this is the case later maturing varieties, like the Mamloxi are preferable. There is always a chance of complete loss with late maturing varieties.

5. At least a bushel or 60 pounds of beans should be planted to an acre. If the rows are narrow, the rate of seeding should be heavier.

6. If soybeans have not been grown on the same land previously, the seed should be inoculated.

7. The beans should be cultivated two to four times, depending upon the season.

8. Timely harvesting is very important. Early maturing varieties often shatter if left too long. By planting both an early and a late variety, the peak labor requirements at harvest time are reduced and also the danger of a complete loss eliminated, if fall rains should prevent late harvesting.

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[11] In addition to the monetary returns per acre, there are certain non-monetary considerations in that growing soybeans affords an opportunity for farmers to improve the general condition of the poorer soils and at the same time receive cash remuneration.

SUMMARY

1. The yield of soybeans in the Louisiana Mississippi Delta Area is below national average yields and particularly those in the North Central States.

2. It is probable that the Louisiana Mississippi Delta Area should not increase soybeans beyond a total of 66,000 acres, the acreage intended at planting time in 1943, because of more favorable production alternatives.

3. Labor requirements for producing the major crops vary widely. Cotton requires approximately 19 times as much man labor as soybeans; corn, nearly 2 times as much; and oats, three-fourths as much. Soybean production does not compete seriously with cotton for labor, but to a large extent labor requirements for soybeans and corn coincide in timing. This, however, is not a serious conflict, because requirements per acre for soybeans and corn are relatively small.

4. The experience of farmers in 1942 was not favorable where the growing of soybeans resulted in the reduction of more profitable alternative crops. On many farms, however, the production of soybeans as a commercial crop provided a means for utilizing land, equipment, and labor which did not have a better alternative use, or which in some cases would not have been utilized at all. Among the most important production obstacles encountered were the choice of a suitable oil variety, inadequate knowledge of the best cultural methods, and an unfavorable soybean season.

5. At 1942 price relationships the return per acre from soybeans was $7.38, as compared with $15.98 from oats, $16.07 from corn, and $85.75 from cotton, when the yield of soybeans was 11 bushels an acre; oats, 42 bushels; corn, 24 bushels; and cotton, 540 pounds of lint.

6. With the price of soybeans supported at $1.80 a bushel and yields of at least 15 bushels, soybean production offers favorable income possibilities as a cash crop alternative to other crops on many delta farms. Soybeans yielding 15 bushels an acre and selling for $1.80 appear to be more profitable in dollars and cents per acre and per hour of work than oats yielding 42 bushels and selling for $0.50 a bushel, or corn yielding 24 bushels and selling for $1.00 a bushel.

7. Certain size and type of farms will find the expansion of soybean production more practical than others. The plantations without a livestock enterprise are more flexible in organization and should find it feasible to substitute soybeans for feed crops when soybeans appear to be more profitable, whereas the plantations with a livestock program are limited in the extent to which soybeans may be substituted for feed crops. Small farms, without radical reorganizations in size and changes in equipment, are not readily adaptable to soybean production.

8. The fact that soybean production is completely mechanized and requires highly skilled man labor, whereas cotton production utilizes family labor, which is labor of a much lower grade, limits the extent to which soybean expansion would be feasible in the attainment of maximum wartime utilization of resources. Even though much less labor is required for producing an acre of soybeans than cotton, it cannot be concluded that unlimited soybean expansion would be the most desirable or most efficient use of resources where the farm force is growing scarce, because of the difference and variations in skills required in the production of soybeans and cotton.

The author is indebted to Professor B. M. Gile, Head, Department of Agricultural Economics, for his criticism and editorial assistance. Mr. C. B. Haddon, Superintendent of the Northeast Louisiana Agricultural Experiment Station, Mr. R. A. Wasson, Extension Agronomist, and Mr. C. P. Seab, County Agent, read the manuscript and offered helpful suggestions.

APPENDIX

TABLE 1.—Usual operations, man, tractor, mule and truck requirements for producing an acre of soybeans, Louisiana Mississippi Delta Area[1]

USUAL OPERATIONS	Times over	HOURS			
		Man	Tractor	Mule	Truck
Fall Plowing					
Disc	1	.7	.7	....	....
Break	1	.6	.6	....	....
TOTAL		1.3	1.3	....	....
Prepare and Plant					
Disc	1	.6	.6	....	....
Break	1	.7	.7	....	....
Disc harrow	1	.6	.6	....	....
Plant	1	.6	.2	.8	....
TOTAL		2.5	2.1	.8	....
Cultivate and Harvest					
Cultivate	4	2.0	2.0	....	....
Combine beans[2]	1	2.4	1.1	....	....
Haul in	1	1.4	....	....	1.3
TOTAL		5.8	3.1	....	1.3
TOTAL, ALL OPERATIONS		9.6	6.5	.8	1.3

[1] Average 25 plantations, Concordia Parish. Soybeans grown by the operator with hired labor—mechanized.

[2] Average yield of soybeans harvested, 11 bushels per acre.

TABLE 2.—Usual operations, man, tractor, mule and truck requirements for producing an acre of oats, Louisiana Mississippi Delta Area, 1942[1]

USUAL OPERATIONS	Times over	HOURS			
		Man	Tractor	Mule	Truck
Prepare, Plant and Fertilize					
Flat break	1	1.5	1.5	....	....
Disc	2-3	1.4	1.4	....	....
Plant[2]	1	.4	.3	.2	....
Disc in[2]	0-1	.3	.3	....	....
Fertilizer	0-1	.1	....	.2	....
TOTAL		3.7	3.5	.4	....
Harvest[3]					
Combine	1	1.6	.8	....	....
Haul in	1	1.7	....	.6	.4
Stir oats	0-2	.1	....	....	....
TOTAL		3.4	.8	.6	.4
TOTAL, ALL OPERATIONS		7.1	4.3	1.0	.4

[1] Average 25 plantations, Concordia Parish. Oats grown by the operator with hired labor—mechanized.

[2] Oats planted with either grain drill or ingate seeder.

[3] Average yield of oats 42 bushels per acre.

TABLE 3.—Usual operations, man, tractor and mule requirements for producing an acre of corn, Louisiana Mississippi Delta Area, 1942[1]

USUAL OPERATIONS	Times over	HOURS		
		Man	Tractor	Mule
Fall Plowing				
Disc	1	.6	.6	....
Break	1	.8	.8	....
TOTAL		1.4	1.4	....
Prepare and Plant				
Disc	1	.6	.6	....
Break	1	.6	.6	....
Disc harrow	1	.5	.5	....
Plant	1	.6	.2	.8
TOTAL		2.3	1.9	.8
Cultivate, Hoe, Fertilize				
Cultivate	3-5	1.6	1.6	....
Hoe	0-1	4.3	....	....
Apply fertilizer	0-1	.4	....	.3
TOTAL		6.3	1.6	.3
Harvest				
Pull and haul in[2]	1	7.9	....	4.6
TOTAL		7.9	....	4.6
TOTAL, ALL OPERATIONS		17.9	4.9	5.7

[1] Average 25 plantations, Concordia Parish. Corn grown by the operator with hired labor—mechanized.

[2] Average yield 24 bushels per acre.

TABLE 4.—Usual operations, man, tractor and mule requirements for producing an acre of cotton, Louisiana Mississippi Delta Area, 1942[1]

USUAL OPERATIONS	Times over	HOURS PER ACRE		
		Man	Tractor	Mule
Seeding Legumes				
Disc or cut stalks	1	.6	.6	....
Plant legumes	1	.6	.2	....
Break	1	.6	.6	.5
TOTAL		1.8	1.4	.5
Prepare and Plant				
Disc vetch	1-2	.7	.7	....
Break	1	.8	.8	....
Disc or disc harrow	1	.6	.6	....
Plant	1	.6	.3	.6
TOTAL		2.7	2.4	.6
Cultivate, Hoe, Etc.				
Cultivate	6-10	4.3	3.9	1.3
Hoe	2-4	42.4	....	....
Poison	0-3	.2	.1	.1
Fertilizer	1	1.2	....	.8
TOTAL		48.1	4.0	2.2
Harvest[2]				
Pick	2-3	128.2	....	....
Load and haul to gin	....	2.8	....	....
TOTAL		131.0	....	....
TOTAL, ALL OPERATIONS		183.6	7.8	3.3

[1] Average 25 plantations, Concordia Parish. Cotton grown by the operator with hired labor—mechanized.

[2] Average yield of seed cotton, 1590 pounds per acre; estimated rate of picking 124 pounds per 10-hour day.

TABLE 5.—The average cost of operating a tractor per 10-hour day and per hour, Louisiana Mississippi Delta Area, 1942

ITEM	Unit	PER 10-HOUR DAY			Cost per hour
		Quantity	Price	Cost	
		Unit	*Dollars*	*Dollars*	*Dollars*
Direct cash costs[1]					
Fuel oil	gal.	20.0	0.085	1.70	0.170
Lubricating oil	quart	1.6	0.15	0.24	0.024
Gas	gal.	1.0	0.19	0.19	0.019
Grease	lb.	1.1	0.11	0.12	0.012
Filter	....	....	....	0.10	0.010
Other costs					
Repairs[2]	....	....	....	1.16	0.116
Depreciation[3]	....	....	....	2.04	0.204
Interest[4]	....	....	....	0.43	0.043
TOTAL COST				5.98	0.598

[1] All hired labor costs are excluded.

[2] Average annual repairs for 77 tractors was $118 per tractor. Average number of days used for all tractors was 102 10-hour days per year.

[3] Average value of new tractors was $1292. Average of estimated years of use 6.2.

[4] Charge for interest figured at 6 per cent of the average estimated value of tractors.

TABLE 6.—Average annual cost of operating a combine, Louisiana Mississippi Delta Area, 1942[1]

ITEM	Oats	Soybeans	Total annual cost of combines
	Dollars	*Dollars*	*Dollars*
Repairs[2]	13.33	24.51	37.84
Depreciation[3]	63.51	63.51	127.02
Interest[4]	15.30	15.30	30.60
TOTAL	92.14	103.32	195.46
Cost per acre[1]	1.06	1.29	......

[1] Average for one and two row combines, excluding combines with motor attachments. Allocation of costs to oats and soybeans based upon 80 acres of soybeans harvested, and 87 acres of oats.

[2] Farmers estimate that two-thirds of repair costs should be charged to soybeans and one-third to oats.

[3] Average original cost of combines estimated to be $762.12 and average years of use estimated to be six years when oats and soybeans are both harvested.

[4] Charge for interest figured at 6 per cent of the average estimated value of combines.

TABLE 7.—Average annual cost of operating tractor equipment by crops, per acre, Louisiana Mississippi Delta Area, 1942[1]

ITEM	Cotton	Corn	Oats	Soybeans	Other crops	Total cost of equipment
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Repairs[2]	72.50	36.80	21.16	36.80	16.74	184.00
Depreciation[3]	104.02	52.80	30.36	52.80	24.02	264.00
Interest[4]	22.46	11.40	6.55	11.40	5.19	57.00
TOTAL	198.98	101.00	58.07	101.00	45.95	505.00
Cost per acre	0.99	0.60	0.67	0.86	0.96	0.81
Acres in crops	*201*	*168*	*87*	*117*	*48*	*621*

[1] Tractor equipment includes tractor plows, middle busters, cultivators, discs and planters.

[2] Annual estimated repairs by the operator.

[3] Estimated 6 years of use and average original cost estimated at $1584 per farm.

[4] Charge for interest figured at 6 per cent of the average estimated value of the equipment.

LOUISIANA BULLETIN NO. 370 NOVEMBER 1943

A STUDY OF BREEDING RECORDS
IN
DAIRY HERDS

by

D. M. SEATH, C. H. STAPLES AND E. W. NEASHAM

DAUGHTERS OF PABST PRILLY CREATOR PRINCE 482743
(see inside front cover)

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS
W. G. TAGGART, *Director*

The picture on the front of this bulletin shows four daughters of Pabst Prilly Creator Prince 482743. This is a sample of his 80 daughters of good type which averaged M.E.3x basis 12,940 lbs. of milk and 449 lbs. fat. This sire is one of four successive good proved sires which helped build the L.S.U. Holstein herd.

A STUDY OF BREEDING RECORDS IN DAIRY HERDS

D. M. SEATH,* C. H. STAPLES,** AND E. W. NEASHAM***

Dairying is increasing in importance in Louisiana. Recent years have witnessed its rise to a major position as a source of agricultural income. In 1942 the farm cash income from milk totaled $21,415,000.[1] Total number of cows two years old and over kept for milk on farms January 1, 1942 was estimated at 338,000. The average number of cows milked during 1942 was 290,000, thus, making an average income per cow from milk of $73.84. Sale of young stock and cows culled added approximately $6,685,000 to the yearly dairy income.[2] The total 1942 dairy income would, by this addition, approximate $28,100,000 or 13 per cent of the total Louisiana farm income.

Louisiana is blessed with several advantages favoring dairying. Among them is a long growing season. This makes it possible to have cattle procure their own feed from pasture during most of the year. The warm climate also makes it unnecessary to construct expensive housing facilities. The prevalence of small farms in Louisiana makes it necessary that an intensive type of agriculture be followed. Dairying meets this requirement by giving relatively large returns in proportion to the size of business involved.

Too few good cows inhibit a more rapid advancement of dairying in Louisiana. While certain individuals have high-producing herds which are profitable even during unfavorable periods, the State's average milk and butterfat yields per cow rank comparatively low. The 1942 estimate shows an average of 1,056 quarts or 2270 pounds of milk per cow. Contrasted to this, the 1941-42 average cow in Louisiana dairy herd improvement association herds produced 5,505 pounds of milk and 260 pounds of butterfat. This is approximately double that produced by the average Louisiana cow. Improvement in the average production of all Louisiana cows will result from improving both the inheritance and the feeding of dairy herds.

Herd improvement through breeding results from the adoption of two programs; namely, the use of better bulls, and the close culling of herds. The two programs should operate hand in hand. Each bull's daughters should average higher in production than their dams, and among those daughters culling should eliminate the poorer ones. This will result in having only the better cows leave offspring to perpetuate the herd.

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*Dairy Husbandman and Head, Dairy Research Department

**Professor and Head, Department of Dairying, College of Agriculture.

***Extension Dairyman, Extension Division.

[1] Data furnished by Bureau of Agricultural Economics, U.S.D.A.

[2] Value of dairy animals sold as beef was estimated by use of data on young stock numbers and average replacement percentages shown in other studies.

MATERIAL AND METHODS

Data from the Louisiana State University dairy herd and the North Louisiana Experiment Station herd have been used for this study. All lactation records were standardized by the use of conversion factors determined by the Bureau of Dairy Industry, U.S.D.A.[3] These tabulations were based on 305-day lactations, twice-a-day milking and a mature-equivalent basis. This means that all records longer than 305 days were reduced in length, that cows milked three times daily had their records proportionately reduced, and that conversion factors were used to standardize all records to a mature basis. Proved-sire and cow-family data as submitted by the Bureau of Dairy Industry for herd analyses were also utilized in the study. The breeding and calving records used were those kept as a routine practice in the two herds.

THE IMPORTANCE OF USING BETTER SIRES

Few people can afford to improve their dairy herds by continually buying females. Both the cost in money and the disease hazard are too great to warrant the general adoption of this procedure. This knowledge causes most dairymen to secure improvement through the use of better bulls. Under such a program it behooves the dairyman to select a bull with an inheritance better than that of his present herd.

High vs. Low Producing Herds

The value of a good bull can best be visualized by comparing returns from high and low producing herds. Such a contrast was pointed out in a recent study of dairy herd improvement records in Louisiana.[4] The eleven high herds for 1938 excelled the eleven low herds by 67 per cent in the production of 4 per cent milk and showed 69 per cent more returns above feed cost. At $2.00 per hundred for 4% milk, the returns over feed cost per cow favored the high producing herds by $29.10 per year. For a herd of 20 cows the returns would be $582 greater than for a low producing herd of the same size. At 1943 feed and milk prices this difference in yearly income would be almost double that given. Such differences in yearly income well justifies all efforts made to breed cows capable of high production.

Bulls Measured by Dam–Daughter Comparisons

It is becoming increasingly common for dairymen to measure the value of a bull by comparing the production of his daughters to the production of their dams. When five or more such comparisons are available this is considered the most reliable method of evaluating a bull's breeding value. Such comparisons are commonly reported as follows:

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[3] B.D.I.M.—925. J. F. Kendrick. 1941.

[4] Louisiana Experiment Station Bulletin 338, D. M. Seath and E. W. Neasham, 1942.

ANIMALS	Records Averaged	Milk	Test	Fat
(*Number*)	(*Number*)	(*Pounds*)	(*Percent*)	(*Pounds*)
8 daughters	8	5,973	5.2	313
5 daughters	5	5,988	5.3	316
5 dams	11	5,276	5.1	269
Difference	(4-3-4)	+712	+ .2	+ 47

The above information is for a Louisiana sire[5] and gives evidence that the bull transmitted higher producing ability to his daughters than shown by the dams of his daughters. This bull had a total of 8 daughters with records, and 5 of the 8 had dams with records. It so happens that

GAY POGIS VOLUNTEER 346937

A good Louisiana proved sire still in service at 12 years of age. Eighteen of his daughters had records averaging 8678 lbs. milk and 431 lbs. fat, an increase of 881 lbs. milk and 55 lbs. fat over their dams. Owner is C. B. Billeaud, Lafayette, shown holding bull.

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[5] Sire information from List of Sires Proved in Dairy Herd Improvement Assns. 1942. U.S.D.A. Misc. Pub. No. 487, 1942.

the average production of all eight daughters is almost identical with that of the 5 used in dam-daughter comparisons. The "difference" information, (4-3-4) shows that 4 daughters equaled or excelled their dams in milk productions; 3 daughters equaled or excelled in fat percentage; and 4 equaled or excelled in butterfat production. The actual average difference favors the daughters by 712 pounds of milk and 47 pounds of butterfat per lactation. The butterfat percentage increased by 0.2%. These are significant increases and clearly show the influence of one good bull. As more dam-daughter comparisons become available his influence can be more accurately measured.

Good vs. Poor Sire on Arrow Charts

The dam-daughter method of measuring a bull's breeding performance is often best shown by using an arrow chart. Figure 1 is an example of this kind and displays the breeding performance of an outstanding sire used in the Louisiana State University herd. Note that all but two of the arrows point upward. This indicates a high degree of consistency. The length of the arrows shows the amounts by which the daughters exceeded the butterfat production of their dams. The average increase was 64 pounds of butterfat. Note that the arrows tend to be shorter as the dams' production increases. This trend is in line with that generally experienced and shows why owners of high-producing herds have extreme difficulty in securing sires that will further improve their herds.

FIG. I. A GOOD PROVED SIRE
Dam-Daughter Comparisons of a Sire Used in the L.S.U. Herd

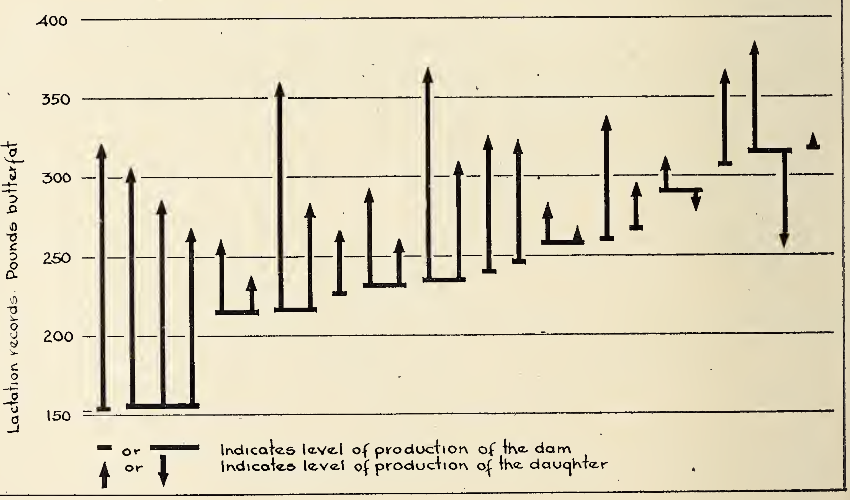
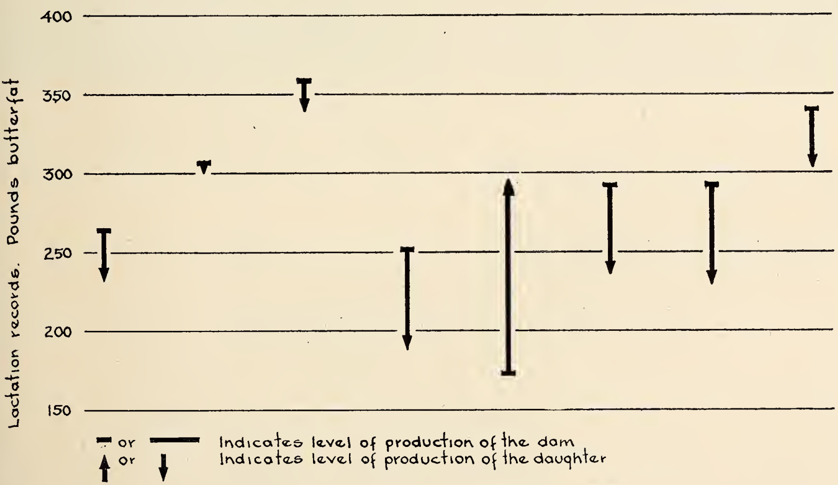


Figure 2 shows graphically the performance record of an inferior bull. In this case most of the arrows point downward. The differences, as shown by the length of arrows, are more variable than was the case in Figure 1. The average reduction in this case was 19 pounds of butterfat per lactation. The loss in production is not great, yet the direction and length of the arrows lack the consistency shown in Figure 1. Only two daughters excelled their respective dams in production, and the production level of dams and daughters is relatively low. One who uses bulls like this one will suffer a distinct loss in his dairy program. This loss will extend over several years, for bulls normally sire three or four calf crops before being replaced and before any of their daughters freshen to give evidence as to their breeding worth.

The American Jersey Cattle Club does not utilize dam-daughter records in proving sires, but instead, uses the average record of 10 or more daughters as a measure of their "Tested" and "Superior" sire ratings.[6] The requirement that a bull have ten or more (rather than 5 or more) daughters before being listed is assumed to make up for the omission of dams' records. There is a good basis for this assumption; yet, the ideal plan would be to have 10 or more dam-daughter comparisons as a basis for selection, for it has been repeatedly shown that the dams contribute approximately one-half the inheritance to their offspring, making it obvious that their production records should be considered when evaluating the sire of their offspring.

FIG. 2. A POOR PROVED SIRE

Dam-Daughter Comparisons with Trend Toward Lower Production



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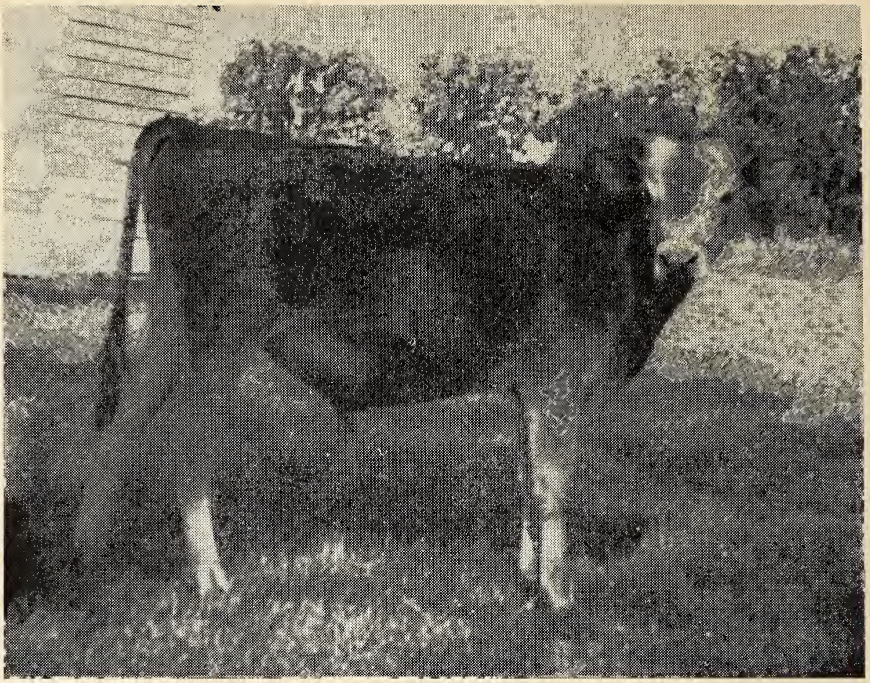
[6] See Tested Sires and Dams of the Jersey Breed, Supplement Volume. American Jersey Cattle Club, New York, N. Y. 1941.



A GOOD PROSPECTIVE SIRE

This calf is of good type and has high producing ancestry. His pedigree rated three stars by American Jersey Cattle Club scoring.

Select Sons of Proved Sires

The preceding paragraphs give valuable information as to the type of information one should look for when selecting a herd sire. It is obvious that only a few can buy sires already proved. On the other hand, most buyers can select sons of good proved sires. Likewise, it is often possible to select a bull whose grandsires have proved good. This sort of ancestry gives valuable evidence that the males appearing in the prospective sire's pedigree had the ability to transmit good inheritance to their offspring. This type of pedigree is shown in Figure 3 and is in direct contrast to the one shown in Figure 4. The latter pedigree is one where little transmitting ability was reported. In other words the bulls had not been proved.

Brood Cow Families Are Important

The sire and the dam each contribute one-half the inheritance in the production of every calf. This means that recognition must be given to the cow families as well as to the sires used in a herd. Those cows in a herd that have outstanding daughters and grand-daughters are usually spoken of as "brood" cows. Such cows have demonstrated that they are

FIGURE 3. AN EXCELLENT PEDIGREE OF A PROSPECTIVE SIRE

PROSPECTIVE SIRE

Born Feb. 14, 1940
A 4-Star bull with
23 credits.

SIRE

Superior and Silver Medal sire
Classified *Very Good.*

10 daughters average 13,028 lbs. milk, 5.4%, and 708 lbs. fat (mature equivalent).

10 daughters classified, 3 *Very Good,* 4 *Good Plus,* 3 *Good.*

DAM

Gold and Silver Medal.
Classified *Very Good.*
Register of Merit Records:

Days	*Age* *Yr.Mo.*	*Milk*	*%*	*Lbs.* *Fat*
365	3 4	11,394	5.7	653
305	6 2	13,007	5.4	707

Has 1 Silver Medal daughter:

305 days, 2 yr. 4 mo., 6597 lbs. milk, 430 lbs. fat (full sister to prospective sire).

PATERNAL GRANDSIRE

Superior, Gold and Silver medal.
49 daughters averaged 11,835 lbs. milk, 5.8%, 690 lbs. fat (mature equivalent)
43 classified daughters:
6 *Excellent,* 16 *Very Good,*
13 *Good Plus,* 7 *Good,* 1 *Fair.*

PATERNAL GRANDAM

Register of Merit Record:
305 days, 7 yr. 7 mo.
11,142 lbs. milk, 4.9%,
542 lbs. fat.

MATERNAL GRANDSIRE

Superior, Gold and Silver Medal.
12 daughters average (mature equivalent) 13,195 lbs. milk, 5.1%,
671 lbs. fat.
11 classified progeny:
4 *Very Good,* 5 *Good Plus,*
1 *Good,* 1 *Fair*
10 tested daughters average 280 lbs. fat more than dams.

MATERNAL GRANDAM

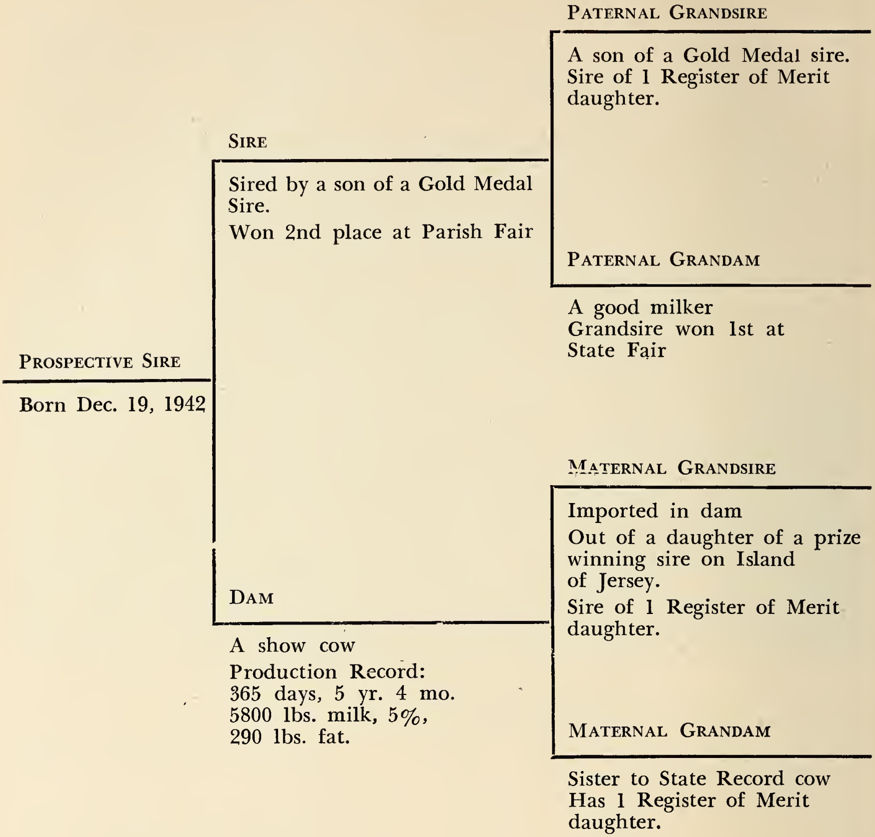
Register of Merit Record:
365 days, 2 yrs. 5664 lbs. milk.
311 lbs. fat.

relatively pure in their inheritance, although the limited number of daughters that a cow can have as compared to a bull makes brood-cow information a less reliable selection basis than is the case with proved sire information. Its use, however, is to be encouraged and usually deserves more emphasis than the actual performance records of females appearing in a pedigree.

Rating Cow Families

An attempt has been made to rate cow families developed in the L.S.U. Holstein herd. The method used is subject to various errors; yet, it helps to distinguish actual differences from generation to generation. Two of the families studied had contrasting performance records, as

FIGURE 4. A Poor Pedigree of a Prospective Sire



Paternal Grandsire

A son of a Gold Medal sire. Sire of 1 Register of Merit daughter.

Sire

Sired by a son of a Gold Medal Sire.

Won 2nd place at Parish Fair

Paternal Grandam

A good milker

Grandsire won 1st at State Fair

Prospective Sire

Born Dec. 19, 1942

Maternal Grandsire

Imported in dam

Out of a daughter of a prize winning sire on Island of Jersey.

Sire of 1 Register of Merit daughter.

Dam

A show cow

Production Record:
365 days, 5 yr. 4 mo.
5800 lbs. milk, 5%,
290 lbs. fat.

Maternal Grandam

Sister to State Record cow

Has 1 Register of Merit daughter.

shown in table 1. The A family in this case started the first generation with a record of 5 pounds less butterfat per cow than did the B family, yet showed an increase each succeeding generation, enabling it to average 81 pounds higher for the third generation than did the B family. Cases such as this one, with a definite upward trend, make selection from such

TABLE 1. Performance of Two Female Families for Three Generations*

Family	1st Generation		2nd Generation		3rd Generation	
	Number Animals	Average Butterfat	Number Animals	Average Butterfat	Number Animals	Average Butterfat
A	2	315	5	356	2	358
B	4	320	7	305	5	277

*Records used were averages of all normal 305-day lactations on a twice-a-day mature-equivalent basis.

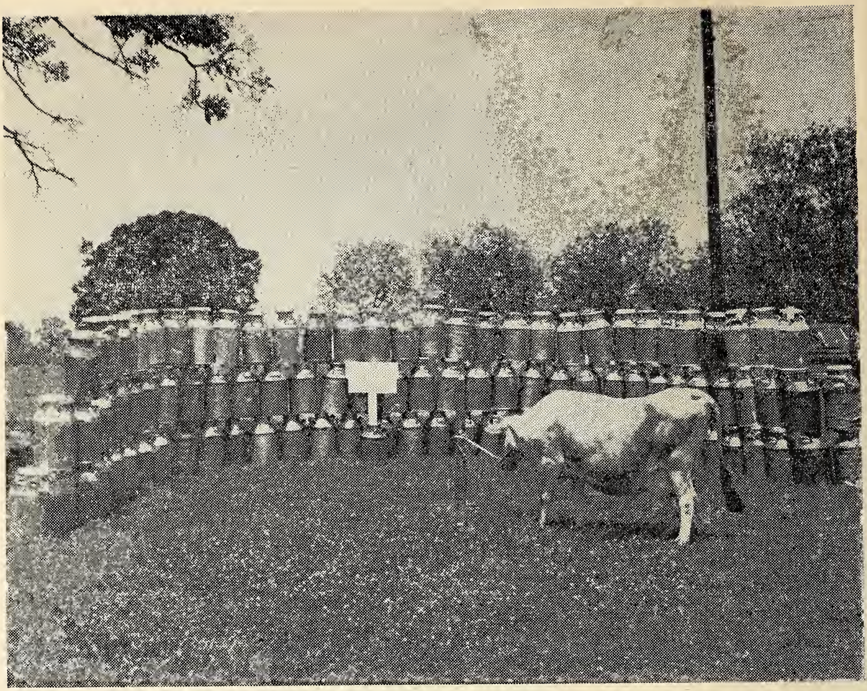
a family much less risky than from one showing a downward trend as with the B family.

A less involved unit than the three-generation group is the selection of a cow having three or more tested daughters. When cows not only have high records themselves, but also have three or more daughters with high records, they make ideal dams for bulls. Some example are given in Table 2. In considering a number of such cases it is well to choose one that ranks toward the top in production and also displays a high degree of consistency in the records made. Some recognition of this is given in Table 3 where the records of both the high and low daughters are given. If only a few pounds separate the high and low daughters, it gives evidence of this consistency. Of those shown, the A family would rank highest in average production of daughters, with each one producing above 330 pounds of butterfat. The spread in production between the high and the low daughters of 78 pounds is greater, however, than for some of the other groups. Family B has less of this spread but is 39 pounds lower in average production of all daughters. Families D and E are illustrations of inferior groups with the production level of daughters definitely lower than for the A, B and C families.

TABLE 2. BROOD COW RECORDS

BROOD COW	BROOD COWS' BUTTERFAT RECORDS		DAUGHTERS' BUTTERFAT RECORDS				
	Number Records	Ave. Fat lbs.	Number Animals	Number Records	High	Low	Ave. of all Daughters
A.	7	258	3	5	406	330	369
B.	9	223	6	28	379	242	330
C.	4	221	3	14	460	261	334
D.	4	310	3	20	309	258	283
E.	7	213	3	9	312	238	270

Examples of the performance of family groups can also be obtained by examining the connected arrows in Figure 1. In such cases the daughters are full sisters. A careful check will show the records of one set of three full sisters and seven sets of two full sisters. The most consistent trend shown by all the groups is for the one with three full sisters. In this case the common dam had low records, averaging 155 pounds of butterfat, while the daughters averaged 269 pounds, 287 pounds, and 307 pounds, respectively. An example of an inconsistent trend is also shown in Figure 1, in the case of the last group of full sisters. In this case the dam averaged 314 pounds of butterfat and one daughter, shown by arrow pointing upward, averaged 372 pounds, and the other shown by arrow pointing downward, averaged 253 pounds.



"OLD" LADY DEMONSTRATES DESIRABLE LONGTIME PRODUCTION

She averaged 110 cans of milk per year for a period of 14 years and 7 months. Lifetime State Champion for butterfat. Total 123,490 lbs. milk and 4746 lbs. fat. Averaged 26 lbs. or 12 quarts for each day in milk. Owned by North Louisiana Experiment Station.

REPLACEMENT PROBLEMS IN A DAIRY HERD

Average Productive Life of Cows

High producing cows that resist disease, avoid injury, and remain in production year after year are much to be desired in dairy herds. A study concerning the variations in the productive lives of 138 Jerseys and 174 Holsteins in the L.S.U. herd revealed information given in Table 3. As is shown in this table, 19.6% of the cows had but one freshening before leaving the herd, 17% had two and 17% had three. Thus, 53.6% (more than half the total) left the herd before having freshened four times. At the other extreme only 10.8% of the total freshened 8 or more times. The average for each breed was 3.78 freshenings.

The time actually spent in the milking herd averaged 3 years and 8.3 months for Jerseys, and 3 years and 9.4 months for Holsteins. The period between the first and last freshening averaged 2 years and 11.9 months for Jerseys and 3 years and 4 months for Holsteins.

TABLE 3. VARIATIONS IN PRODUCTIVE LIVES OF DAIRY COWS

TOTAL FRESHENINGS WHILE IN HERD	Jerseys (*number*)	Holsteins (*number*)	Total (*number*)	Percent of Total
1	30	31	61	19.6
2	25	28	53	17.0
3	19	34	53	17.0
4	22	24	46	14.7
5	13	19	32	10.3
6	12	8	20	6.4
7	2	11	13	4.2
8	4	12	16	5.1
9	3	4	7	2.2
10	2	2	4	1.3
11	5	1	6	1.9
12	1	0	1	.3
TOTAL	138	174	312	100.00
Vverage freshenings	3.78	3.78	3.78	

Sex Ratio and Female Replacements

Data on 350 Bangs-free cows from the time they first freshened and until they left the L.S.U. herd are shown in Table 4. These cows gave birth to 436 normal bull calves and 445 normal heifer calves. The Jerseys had 2 more bull calves than heifers, while the Holsteins had 11 more heifers than bulls. The sex ratio was as near 50:50 as one could reasonably expect. For both breeds the number of female offspring of normal birth during the lifetime of each cow in the herd averaged 42.3% of the total calves. Table 3 showed 3.78 calvings per cow. Thus, 42.3% of 3.78 gives 1.6, or the number of normal heifer calves per cow. With each cow contributing to the herd but 0.6 of a heifer calf over and above actually replacing herself, only a mild degree of culling becomes possible. This fact should cause dairymen with grade cows to avoid in most cases the use of beef bulls, even during short periods when herd-cow numbers seem plentiful. Two and three years after using a beef bull it usually

TABLE 4. LIFETIME CALVING RECORD OF BANGS-FREE COWS

BREED	No. Cows	NORMAL CALVES		ABNORMAL CALVINGS	
		Male	Female	Abortions	Dead at Birth*
Jersey	148	158	156	43	52
Holstein	202	278	289	39	37
TOTAL	350	436	445	82	89
Percent of total Calvings		41.4%	42.3%	7.8%	8.5%

*Includes a few calvings with sex unknown.

becomes apparent that good herd-cow replacements are deficient in number, and as a result, less culling is possible and the quality of the herd suffers a set-back.

Breeding Efficiency of Bulls

Bulls vary in their breeding efficiency as do the female members of a herd. Results from a study of 14 sires mated to 161 cows resulting in 643 conceptions in the L.S.U. herd illustrates in Table 5 this variation among sires. The bull having the best record, (H) 40, required but 13 services for 12 conceptions thus averaging 92.3%. The bull with the poorest record required 56 services for 21 conceptions averaging 37.5%. All of the 14 sires averaged 61.4% conceptions on the 1048 services recorded. Bulls averaging below 50% are commonly considered poor breeders, while bulls above this average are considered good breeders. Proper feeding and abundant exercise are thought to assist in keeping bulls in good breeding condition. The aim is to have the bull carry a medium amount of condition and to avoid the development of a large paunch. In spite of the use of best feeding and management practices, wide variations in the efficiency of bulls are commonly found.

TABLE 5. EFFECT OF SIRE ON REPRODUCTIVE EFFICIENCY (USING SIRES WITH TEN OR MORE DAUGHTERS)

BREED AND NUMBER OF SIRE	Number Cows	Number Services	Number Conceptions	Percentage Conceptions
(H) 40	3	13	12	92.3
(H) 61	2	16	13	81.2
(J) 23	10	39	30	76.9
(H) 19	4	17	13	76.5
(H) 13	43	212	157	74.1
(H) 20	26	94	68	72.3
(J) 21	4	18	13	72.2
(H) 44	7	49	31	63.3
(H) 74	2	19	12	63.2
(J) 14	34	250	142	56.8
(J) 12	12	124	71	56.3
(J) 22	10	30	16	53.3
(J) 45	9	111	44	39.6
(J) 52	3	56	21	37.5
TOTAL OR AVERAGE	161	1048	643	61.4

Breeding Efficiency of Cow Families

A study of the breeding records of the daughters of various dams in the L.S.U. herd also revealed wide variations in breeding efficiency. The results as shown in Table 6 include records on the female offspring of cows having three or more daughters with reproduction records. Sixteen groups listed averaged in percentage conception from a high of 92.3% to a low of 40.6%. These data along with differences noted between

TABLE 6. THE INFLUENCE OF DAM ON REPRODUCTIVE EFFICIENCY (ONLY DAMS WITH THREE OR MORE DAUGHTERS INCLUDED)

BREED AND NUMBER OF DAM	RECORDS OF DAUGHTERS			
	Number Daughters	Times Bred	Number Conceptions	Percentage Conceptions
(H) 516	3	13	12	92.3
(J) 162	4	26	22	84.6
(H) 559	3	10	8	80.0
(H) 545	3	24	18	75.0
(J) 42	4	19	14	73.7
(H) 598	3	10	7	70.0
(J) 18	3	16	11	68.8
(J) 87	3	24	16	66.7
(H) 527	5	28	17	60.7
(H) 595	3	37	22	59.5
(H) 647	3	32	19	59.4
(J) 94	4	9	5	55.6
(J) 35	3	26	14	53.8
(H) 546	3	13	7	53.8
(H) 537	3	22	11	50.0
(H) 586	3	32	13	40.6
TOTAL OR AVERAGE	53	341	216	63.3

sires, would lead to the supposition that a high breeding efficeincy is inherited. If this is true, then culling practices within a herd should eliminate those low in breeding efficiency as well as those having low milk and butterfat production records.

Effect of Gestation Number

Table 7 shows the effect of gestation number on the reproductive efficiency of the experimental herd at the North Louisiana Experiment Station. A relatively low breeding efficiency of this herd prompted the compilation of this data covering a period of 13 years.

The comparisons in general show that the source of a great deal of the reproductive trouble was traceable to approximately one-half each of the first three gestation groups. Twenty-two of the first gestation groups averaged only 1.4 services per conception, while the remaining 18 required 5.3 services per conception. With the second gestation group 9 required an average of 1.9 services, while the remaining 7 required an average of 4.1 services. A like trend is shown for gestation number three. The difficulty of breeding approximately one-half each of the three groups greatly raised their calving age.

The greater difficulty of breeding first-calf heifers as compared to cows has been reported by various investigators. This fact, however, does not explain why approximately one-half of the second and third gestation groups had a low breeding efficiency. Checks of the experimental herd made by veterinarians revealed no disease to explain the condition.

TABLE 7. EFFECT OF GESTATION NUMBER ON REPRODUCTIVE EFFICIENCY (EXPERIMENTAL HERD)

GESTATION NUMBER	Age of Calving (months)	Number of Gestations		Services per Conception	
1	14 - 29	22	40	1.4	3.1
	30 - 56	18		5.3	
2	24 - 41	9	16	1.9	2.9
	42 - 51	7		4.1	
3	46 - 53	5	14	1.2	3.0
	54 - 81	9		4.0	
4	59 - 93	13		2.8	
5	69 - 105	17		2.4	
6	88 - 119	9		2.2	
7-10	100 - 142	13		2.4	
11 and over	167 - 178	4		3.5	

Breeding records of the L.S.U. herd did not show this same trend (Table 8). The data as presented in Table 7 will suggest to the herd owner a method of analysis that can be followed in an effort to determine which group or groups of animals are mostly responsible for lowering a herd's reproductive efficiency.

Effect of Season on Breeding Efficiency

Table 8 presents a summary of a study concerning the effect of season of the year on breeding efficiency. Both the L.S.U. and the experimental herds showed the most services per conception for the summer months.

TABLE 8. EFFECT OF SEASON ON BREEDING EFFICIENCY

	NUMBER OF GESTATIONS		SERVICES PER CONCEPTION	
	Experimental Herd	University Herd	Experimental Herd	University Herd
Fall	22	204	2.7	1.4
Winter	40	399	2.5	1.5
Spring	39	266	2.8	1.9
Summer	45	62	3.4	2.4

This low efficiency may be due to the effect of hot weather and the lack of certain adequate feeds for the proper nourishment of the cows and bulls. The fall and winter months gave the highest breeding efficiency. No adequate explanation, other than cooler weather, can be made for this trend; for, in general, dairy rations are considered less adequate during these two seasons than for spring and summer.

OTHER FACTORS INFLUENCING HERD PERFORMANCE

Length of Dry Period

Table 9 presents the results of comparing the production and reproduction records following various lengths of dry periods. A total of 385 individual comparisons are given for cows in the L.S.U. herd and include two lactations each for 91 cows and three each for 56 cows. As the dry period increased the days between calvings (calving interval) increased, and it is also shown that services per conception tended to increase. The dry period, as one would expect, was apparently influenced some by the breeding efficiency of the individual cows. This could account for only a portion of this trend, however, for the calving interval increased more rapidly than did the dry period. This shows that factors such as a delay in breeding cows so as to have them freshen during fall and winter months also tended to increase this calving interval.

TABLE 9. EFFECT OF DRY PERIOD ON HERD'S PERFORMANCE

DRY PERIOD (*Days*)	Number Lactations	Services per Conception	Calving Interval (*days*)	305-DAY-M. E. LACTATION RECORDS (*lbs. milk*)	(*lbs. fat*)
Under 30	9	1.0	331	6756	239
30- 44	23	1.2	363	8496	317
45- 59	92	1.6	379	8566	311
60- 74	115	1.3	371	8701	323
75- 89	52	1.4	409	8454	308
90-104	30	1.6	406	9770	348
105-119	20	1.6	422	9205	336
120-134	10	2.2	434	7730	312
135-149	4	2.0	427	7250	308
150-164	13	2.1	505	8831	338
165 and over	17	2.8	631	8924	344
TOTAL OR AVERAGE	385	1.6	400	8661	320

Milk and butterfat lactation records show a decided reduction following dry periods of less than 30 days. Irregular trends are shown for the records made by cows that were dry 30 or more days. The highest records were for those with dry periods from 90 to 104 days, but it is improbable that the differences shown are significant enough to justify the time lost or expenditure necessary in feeding cows for the additional periods. It is more probable that dry periods ranging between 30 and 75 days would prove to be the most profitable. Another study[7] has recently shown that 55 days is the most profitable length. The relative physical condition and producing ability of a cow need to be considered in deciding on the length of dry period necessary for her to build up a proper reserve for another lactation period.

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[7] Jour. Dairy Sci. 26, pp. 705-713. John W. Klein and T. E. Woodward. 1943.

Period Between Calvings

In Table 10 is shown a regrouping of the data used for Table 9. In this case the information is arranged according to days separating calvings, or what is called the "calving interval." The comparisons indicate that a calving interval of less than 300 days results in a definite reduction in the production of milk and butterfat for the following 305-day lactation. In general, the calving intervals of less than 350 days are accompanied by lower production records. Calving intervals greater than 350 days tend to be larger and those from 400 to 449 days are the highest of any shown. These data, if converted to a calendar-year basis, would give the short-calving interval cows a better rating than is shown in Table 10. Such cows would produce more calves and probably more milk per calendar year than would any groups having average calving intervals greater than 374 days. Another point supporting this contention is that dry periods are excessively long for all calving intervals greater than 374 days (See Table 10). Breeding cows so that they will freshen with a calving interval of 365 days, or one year, appears to be the best recommendation that can be made based on the information at hand.

TABLE 10. THE INFLUENCE OF LENGTH OF CALVING INTERVAL ON HERD PERFORMANCE

CALVING INTERVAL (*Days*)	Number Records	Dry Period (*days*)	305-DAY M. E. LACTATION RECORDS	
			(*lbs. milk*)	(*lbs. fat*)
Under 300	3	56	5833	230
300-324	48	59	7498	296
325-349	58	62	7916	299
350-374	74	68	8684	317
375-399	62	72	8934	311
400-424	46	78	8974	330
425-449	25	72	9512	348
450-474	14	88	9443	361
475-499	14	118	9214	336
500 524	11	126	7882	313
525 and over	30	169	10,100	365
TOTAL OR AVERAGE	385	80	8661	320

SUMMARY

1. Lifetime production and reproduction records of cows in the Louisiana State University and the North Louisiana Experiment Station herds were used as the principal sources of information for this study.

2. Methods of evaluating bulls and cows are presented. Illustrations are given of good and poor proved sires and the desirability of having sires that uniformly transmit higher producing ability to their daughters than shown by their dams. The evaluation of cow families and of brood cows is also presented with illustration of good and poor performance

records. Extended pedigrees of good and poor prospective sires are also shown.

3. The average number of freshenings found during the productive lives of 138 Jerseys and 174 Holsteins was 3.78. The time actually spent in the milking herd averaged 3 years, 8.3 months for Jerseys and 3 years, 9.3 months for Holsteins.

4. The lifetime calving records of 350 Bangs-free cows showed 436 normal bull calves, 445 normal heifer calves, 82 abortions, and 89 calves dead or sex unrecorded.

5. The breeding efficiency of 14 bulls having 10 or more daughters varied from 37.5% to 92.3% of services resulting in conceptions. All sires averaged 61.4%.

6. Cow families varied in breeding efficiency from a low of 40.6% of services resulting in conceptions to a high of 92.3%. These variations plus those shown between sires give an indication that breeding efficiency may be inherited and that culling should eliminate those with lowest breeding efficiency from herds.

7. Variations between the breeding efficiency for various gestations were found, with the first gestation requiring the most services per conception. Seasonal differences were also found, with the highest efficiency occurring in fall and winter and the lowest in spring and summer.

8. A study of 385 lactation records showed that cows with dry periods of less than 30 days had significantly lower records than those dry for a longer period. Cows dry from 90 to 104 days had the largest records; yet, from an economy viewpoint, it would appear most profitable to have cows dry from 30 to 74 days, depending on their producing ability and physical condition.

9. Calving intervals on 385 records averaged 400 days. Lactation records were relatively smaller following calving intervals of less than 350 days. They were highest for those falling between 425 and 474 days. On the basis of yearly production and economy it would appear most profitable to have cows freshen at intervals of approximately 12 months or 365 days.

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EFFECT OF WHOLE AND CUT SEED ON STAND AND YIELD OF IRISH POTATOES

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W. G. TAGGART, *Director*

EFFECT OF WHOLE AND CUT SEED ON STAND AND YIELD OF IRISH POTATOES[1]

E. L. LECLERG[2]

It is generally recognized that seed-piece decay is frequently serious in the early-planted potato crop in Louisiana. Experiments made in other States indicate that small, whole tubers are usually less subject to decay than freshly-cut seed pieces. Because of this fact some growers in the early-producing areas of Louisiana are now using small, whole tubers for their earliest plantings.

No data are available as to whether better stands and higher yields would be obtained by the use of small, whole tubers as seed for later plantings in Louisiana. Therefore, experiments were made to study the relation of freshly-cut seed pieces, suberized seed pieces, and small, whole tubers to the stand and the yield of 4 varieties of Irish potatoes planted about the middle of February, or somewhat later.

METHODS AND MATERIALS

The experiments included four varieties, Katahdin, Chippewa, Sebago, and Triumph and were made in the spring of the years 1940 to 1943, inclusive, at Baton Rouge, Louisiana. The dates of planting each year were as follows: February 29, 1940, February 17, 1941, March 16, 1942, and February 13, 1943. The tubers of each variety were grown at the Federal Potato Station at Presque Isle, Maine each year and were kept in cold storage at Baton Rouge, Louisiana, until planting time. The tubers for planting whole were carefully selected for a weight of about 1½ ounces each, and tubers of about 6 ounces were selected for cutting into 1½-ounce seed pieces.

About a week prior to planting, half of the 6-ounce tubers of each variety were cut into quarters, so as to make pieces of about 1½ ounces. These cut pieces were carefully spread out for 7 to 10 days to allow suberization (healing) of the cut surfaces. At the time of planting, the remaining large tubers were quartered and planted immediately. Thus there were three different types of planting material, whole, suberized, and freshly cut.

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[1] Cooperative investigations by the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, and the Department of Horticulture of the Louisiana Agricultural Experiment Station.

[2] Pathologist, Division of Fruit and Vegetable Crops and Diseases; headquarters at Baton Rouge, Louisiana.

For the information of the technically-trained reader, the plots in each test were arranged as a split-plot design with the types of seed pieces allocated to the sub-effects. Five replications were used in 1940, 1941, and 1943, and only 4 replications in 1942. The plots were 40 hills in length and planted with 12-inch spacing. The data were analyzed by the analysis of variance.

It should not be concluded that one type of seed piece (hereafter designated as "treatment") results in a higher yield than another when only small differences exist between the yields. There is no way to determine relative yielding ability of any treatment with absolute accuracy. Difference in yield from adjacent plots may occur even when planted from the same seed lot and is due in most cases to differences in soil. This effect of soil differences on the estimation of yielding ability is overcome to a considerable extent by having a number of plots (replications) of each treatment in the test. Even with such replication, some of the differences may result from causes other than the treatments, and this part is said to be due to chance.

Methods of analysis of yield data are available to determine how large the difference must be between the yield from any two treatments for it to be considered a real difference. At the bottom of Table 3 is given the "differences required for significance" between the mean yields of any two treatments (types of seed pieces). For the yield of two treatments to be significantly different from each other the difference between the mean yields should be as great as or greater than the figures given at the bottom of Table 3. For example, compare yields from freshly-cut pieces and whole tubers where the difference is 33.1 bushels (184.2—151.1=33.1). This difference is more than the 11.7 bushels needed for statistical significance, which indicates that the yield is greater from the whole tubers because of the type of seed material used, and not merely because of chance variations.

EXPERIMENTAL DATA

Stands

The percentages for stands about 4 to 5 weeks after planting (early) are given in Table 1. From these data it appears that emergence was most rapid from freshly cut seed in 1940, but was more rapid from whole seed in 1941 to 1943, inclusive. In 1940, the reduction in percentage stand of whole tubers as compared with freshly-cut seed pieces of the Chippewa variety was not so great as it was with the other three varieties. As an average of the 4 years, however, stands of each variety about 4 weeks after planting were better from small, whole tubers than from freshly-cut seed pieces (Table 2). Thus plants from whole seed usually emerged sooner than from freshly-cut seed pieces.

TABLE 1. STANDS IN PERCENTAGES, ABOUT FOUR TO FIVE WEEKS AFTER PLANTING (EARLY) AND PRIOR TO HARVEST (AT HARVEST), RESULTING FROM THE USE OF THREE TYPES OF SEED PIECES AND FOR FOUR VARIETIES OF POTATOES AT BATON ROUGE, LOUISIANA, IN 1940-1943, INCLUSIVE

VARIETY	KIND OF SEED PIECE	DATES AND PERCENTAGE STANDS							AVERAGE STANDS (%)	
		EARLY				AT HARVEST				
		1940	1941	1942	1943	1940	1941	1943	Early	At Harvest
Sebago.......	Freshly cut......	88	62	70	48	100	98	98	67	99
	Suberized........	50	58	60	25	98	95	82	48	92
	Whole..........	58	80	85	55	98	100	98	70	99
Chippewa.....	Freshly cut......	98	40	70	52	100	88	65	65	95
	Suberized........	85	35	65	40	98	72	78	56	83
	Whole..........	88	82	75	68	100	100	100	78	100
Katahdin.....	Freshly cut......	72	35	48	28	100	92	98	46	97
	Suberized........	40	32	45	12	100	90	88	32	93
	Whole..........	40	75	80	32	100	98	100	57	99
Triumph......	Freshly cut......	95	50	82	40	100	98	98	67	99
	Suberized........	68	65	80	30	98	100	95	61	98
	Whole..........	68	90	88	48	100	100	98	74	99

TABLE 2. AVERAGE PERCENTAGE STANDS FOR FOUR SEASONS, ABOUT FOUR WEEKS AFTER PLANTING AND AT HARVEST, OF FOUR POTATO VARIETIES FROM THREE TYPES OF SEED PIECES, AT BATON ROUGE, LOUISIANA, 1940-1943, INCLUSIVE

VARIETY	TYPE OF SEED PIECE AND PERCENTAGE STAND		
	Freshly cut	Suberized	Whole
About 4 weeks after planting			
Sebago..................................	67.0	48.2	69.5
Chippewa................................	65.0	56.2	78.2
Katahdin................................	45.8	32.2	56.8
Triumph.................................	66.8	60.8	73.5
AVERAGE.........................	61.1	49.4	69.5
At Harvest			
Sebago..................................	98.6	91.6	98.6
Chippewa................................	95.3	82.6	100.0
Katahdin................................	96.6	92.6	99.3
Triumph.................................	98.6	97.6	99.3
AVERAGE.........................	97.3	91.2	99.3

From the data on percentage stands prior to harvest (at harvest) in Table 1 it appears that the number of plants produced from suberized seed is slightly below that from freshly-cut or whole seed (Tables 1 and 2). It would appear, that on the average, the freshly-cut seed was somewhat slower in germinating than were the whole tubers. The stands at harvest, as an average of the 4 seasons for each variety tested, obtained from freshly-cut seed and whole tubers are nearly the same. Of course, the important consideration in this respect is whether or not these stand differences are reflected in increased yields.

Yield of Primes

The yield of primes (No. 1 tubers) obtained for each variety from the 3 types of seed pieces for the years 1940-1943, inclusive, are presented in Table 3. In 1940, the suberized seed emerged more slowly than did the freshly cut seed (Table 1), but it resulted in higher yields of primes (Table 3). This was true with Sebago, Chippewa, and Triumph varie-

TABLE 3. YIELDS OF PRIMES FROM THREE TYPES OF SEED PIECES AND FOUR VARIETIES OF POTATOES GROWN AT BATON ROUGE, LOUISIANA, IN 1940-1943, INCLUSIVE

KIND OF SEED PIECE	VARIETY AND AVERAGE YIELD (BUSHELS)				Average Yield†
	Sebago	Chippewa	Katahdin	Triumph	
*1940**					
Freshly cut	181.6	184.8	181.1	144.3	172.9
Suberized	220.5	219.2	201.9	200.9	210.6
Whole	181.4	167.1	178.8	158.8	171.5
*1941**					
Freshly cut	194.4	171.7	125.4	158.9	192.0
Suberized	192.3	184.4	233.4	150.5	197.2
Whole	230.6	220.2	268.6	180.1	233.2
*1942**					
Freshly cut	170.6	203.8	153.4	129.3	164.3
Suberized	184.1	199.2	124.1	127.8	158.8
Whole	233.2	236.3	222.0	169.2	215.2
*1943**					
Freshly cut	145.0	90.9	120.0	62.1	104.5
Suberized	173.5	117.5	126.6	97.5	128.8
Whole	169.9	108.2	133.4	89.9	125.3

	1940	1941	1942	1943
*Diff. req. for sig. between seed pieces within a variety.	24.1	30.8	21.6	16.9
†Diff. req. for sig. between seed pieces as an average of 4 varieties.	12.0	15.4	10.8	8.4

ties, but with Katahdin the difference in yield between these 2 types of seed pieces was not statistically significant. Generally speaking, the yield from suberized seed as compared with freshly-cut seed is significantly higher when considered as an average of all varieties and seasons (Table 4).

A comparison of whole tubers with freshly-cut seed for all varieties and years (Table 3) shows that whole seed significantly outyielded freshly-cut seed 10 times out of 16, whereas in the other 6 experiments the difference in yield did not reach the level of significance. Table 4 shows that, as an average of all the tests, the yield from whole tubers is significantly greater than that from either freshly-cut or suberized seed potatoes. The increase in yield from whole tubers as compared with that from freshly-cut or suberized seed pieces is probably due to faster sprouting of the whole tubers and the protection afforded from the attack of seed-piece-decaying organisms.

TABLE 4. AVERAGE YIELDS OF POTATOES FROM THE USE OF THREE TYPES OF SEED PIECES AS AN AVERAGE OF FOUR SEASONS AT BATON ROUGE, LOUISIANA

VARIETY	KIND OF SEED PIECES AND YIELD (BUSHELS)		
	Freshly cut	Suberized	Whole
Sebago	172.9	192.6	203.8
Chippewa	162.8	180.1	183.0
Katahdin	145.0	171.5	200.7
Triumph	123.6	144.2	149.5
AVERAGE*	151.1	172.1	184.2

*Diff. req. for significance = 11.7 bu.

In the case of Triumph, which is the red-skinned variety raised in the early-crop sections of Louisiana, the yield was 149.5 bushels from whole tubers and only 123.6 bushels from freshly-cut seed, as an average of the 4 years (Table 4). Likewise, the yield from whole seed of Katahdin, which is the principal white-skinned variety in Louisiana, was 200.7 bushels, as compared with 145.0 bushels from freshly-cut seed.

SUBERIZATION OF SEED PIECES

Suberization (healing) is favored by slow rather than rapid drying of the cut surfaces of seed pieces. This is best accomplished by the storage of cut seed pieces in an environment of relatively high humidity and moderated temperature for about a week. It has been found that the most favorable humidity is between 85 and 90 per cent of saturation. The humidity can be maintained by keeping wet sacks over the crates of seed pieces. A temperature of 60° to 65° F. is best for proper healing. Care should be taken to insure that the temperature does not greatly exceed 65° F. as rotting of the seed pieces may occur.

The freshly-cut seed pieces should be put into slatted crates. After the seed pieces have stood for about 24 hours from cutting, they should be poured from one crate to another to break apart the pieces sticking together.

Suberization is not recommended unless it can be properly carried out, since partial suberization is not beneficial. Few growers will have ideal conditions for application of this procedure. Therefore, with no experience in healing seed, it is recommended that a small lot of seed be tried at first.

GENERAL CONSIDERATIONS

The fact that the yield from whole seed is equal to or higher than that from freshly-cut seed pieces represents a profit to the owner. In addition, the labor required to cut seed pieces is eliminated by the use of such tubers. With continued scarcity of experienced labor the elimination of the cutting operation can become an important factor in potato production.

U. S. No. 1 B tubers (size 1½ to 2 inches) would be very satisfactory for planting without cutting. Quotations for U. S. No. 1 B range from 10 to 20 cents less than U. S. No. 1 (size 1⅞ inches and larger). The County Agricultural Agent can assist in securing certified seed of this type.

Because the Katahdin variety has so few eyes, a loss of 20 to 30 per cent may result in cutting. It is apparent, therefore, that a sack of U. S. No. 1 B tubers probably would plant a greater amount of land than would a sack of U. S. No. 1 tubers. Thus a saving could be effected by the use of small, whole tubers instead of using cut seed pieces made from U. S. No. 1 tubers. This in addition to the elimination of cost of cutting would represent a considerable saving.

A different situation may exist with the use of small tubers of the Triumph variety. This potato has many eyes and usually no loss results in cutting. Hence a sack of U. S. No. 1 tubers may plant a somewhat larger area than a sack of U. S. 1 B. However, in this case, as with Katahdin, the cost of cutting would be eliminated and would represent a small saving in cost of production.

SUMMARY

Yield tests were made with 4 varieties of Irish potatoes using freshly-cut seed pieces, suberized seed pieces, and small, whole tubers at Baton Rouge, Louisiana, from 1940 to 1943, inclusive.

As an average of the 4 years and 4 varieties, stands 4 to 5 weeks after planting were better from small, whole tubers than from freshly-cut seed pieces or from suberized seed pieces. Likewise, the yield of prime potatoes, on the average, was greater from whole tubers than from either freshly-cut seed pieces or suberized seed pieces. The yield from suberized seed pieces was generally greater than that from freshly-cut pieces.

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STUDIES WITH THE GLADIOLUS IN SOUTH LOUISIANA

by

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STUDIES WITH THE GLADIOLUS IN SOUTH LOUISIANA

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INTRODUCTION

The gladiolus is one of the most popular and generally known flowers. It is not difficult to grow when good corms, often called bulbs, are planted and conditions for growth are favorable. It is used primarily as a cut flower and as such it has few rivals. The fact that gladiolus flowers usually have no odor may be considered a disadvantage, but no odor is often better than too much, especially around the sick room.

In the lower South the gladiolus is extensively grown in home yards and for local sales. For several years it has been grown on a large scale as a commercial cut flower to be shipped to other parts of the country during the winter and spring seasons. The gladiolus does not thrive under hot, dry weather conditions. It will stand light freezes and frosts without serious injury especially when the plants are small, but will be injured or killed by hard freezes.

The work reported in this paper was conducted largely for the home gardener, but it is hoped that it may be of some value to all interested in growing gladiolus in the lower South. Gladiolus are said to "run out" if grown continuously in this part of the country for several years. It is known that Irish potatoes grown in the spring in the South, kept in cold storage and used as seed potatoes the following spring do not produce as well as potatoes grown from new seed from the North. In Irish potatoes the length of dormant period of the tubers used for seed materially affects the character of the plant growth. It was thought that the gladiolus might be similarly affected. Spring grown gladiolus in the South mature corms in the summer under conditions not favorable to the gladiolus. Corms produced from blooming plants under such conditions are always very flat. There was a general belief that the height of crown of the corm had a marked influence on the plant produced, but the work of Grove (2) did not confirm this belief. Apart from the running out effect, information was desired on the size of corm to plant, effect of flowers on corm production, production of corms from cormels, storage of corms and adaptability of varieties to this area.

Procedure

All of the work was conducted on grounds of the experiment station. The same soil was planted to gladiolus every other year, which was not a good thing to do from a disease control standpoint. Twenty corms were planted to each plot, which was three and one-half feet wide by 10 feet long. Five replications were used per treatment and as corms were planted six inches apart in the row, 100 were used per treatment or type. A 4-12-4 fertilizer was applied at the rate of 800 pounds per acre before planting and after the plants had come up to a stand they were top dressed with nitrate of soda at the rate of 200 pounds per acre. Unless otherwise stated corms were set out the last of January or early in February. The Picardy variety was used almost exclusively except for the variety studies. The term "new corms" is used in this bulletin to indicate those obtained from the North which were grown from cormels, to differentiate them from the corms grown in Louisiana.

"Running Out" or Deterioration

Many people plant mixed varieties of corms and save those produced to plant year after year. After a few years only a few inferior kinds remain, but these have often increased until about the same number or more are planted each year. They are usually of the more hardy primulinus types. The better varieties have been lost due to insect or disease injury or failure to increase themselves. Because the better varieties have been lost and the ones remaining may not look exactly as they did at first, the belief is sometimes held that varieties have actually changed to other kinds. This of course does not happen.

Grove (2) states that it is conceivable that if grandiflorus types of gladiolus were subjected to optimum environment and horticultural treatment, the condition of "running out" should not be prevalent. Disease complicates the determination of deterioration of a variety of gladiolus when grown for several successive years in south Louisiana. Gladiolus of the Picardy variety were grown to get information on this problem. New corms were obtained and planted each year from 1938 through 1942. Corms produced each year were planted the following year. Thus corms that were obtained in 1938 produced corms for four years in Louisiana in this experiment, those obtained in 1939 produced corms three years, etc. Each year the production of 100 new corms was compared with that of 100 corm lots grown in Louisiana. Only No. 1 size selected corms were used. For the first three years corms were stored at 40°F during the dormant period, but the fourth year they were kept in common storage.

The results of bloom production are shown in Table 1. The number of flowers from 100 new corms varied considerably, though they always bloomed well and produced good bloom spikes. The results from the Louisiana grown corms were variable, but as long as corms were stored at 40°F fair results were obtained. When stored in common storage corms which had been grown for more than one year in Louisiana produced plants that were severely damaged with fusarium wilt. So few corms were produced that this experiment had to be discontinued. Many blooms from Louisiana grown corms were good, but they were not consistently as good as those from new corms. There were more faulty flowers and the opening of individual florets was often not as good.

Two other varieties, the Minuet and Margaret Fulton, were grown continuously in Louisiana for five years, but only observations were made on them. They were not as badly injured from fusarium as was the Picardy variety, but they did deteriorate over the period of years. This was especially true with the Minuet. Though they came from good size sound No. 1 corms the plants were very small with short, compact flower spikes, and they bloomed late.

Table 1. Production of Blooms From 100 New Corms Compared With That From Corms Which Had Been Grown in South Louisiana From One to Four Years.

Year	Bloom produced from 100 corms				
	New corms	Years corms grown in Louisiana			
		1	2	3	4
1938	126				
1939	145	89			
1940	110	143	126		
1941	165	98	115	96	
1942	115	139	11	17	37

It appears from results obtained that flowers of some varieties of gladiolus did deteriorate when grown for several years under the conditions of this experiment. It seems likely that other varieties will also. This means that it would probably be best to get new corms every second or third year. It is probable that the maturity of corms under the unfavorable conditions of mid-summer play a part in the deterioration. Best results can be obtained with gladiolus in South Louisiana if healthy new corms are planted each year. This would tend to reduce injury from disease, make possible cutting with longer stems, and would allow the removal of the plants as soon as blooms are cut, thus preventing the plants having to remain for six weeks or more after the blooming season. It also prevents care of the corms over the dormant season. This cannot be generally recommended because of the cost.

Size of Corm

Usually three sizes of corms, No. 1's, No. 2's, and No. 3's, are offered for sale as blooming size. Sometimes giant sized corms are sold. The smaller sizes have at times been recommended because they were said to produce good blooms over a longer period of years. To get information on the production of the different grades, new corms were planted each year from 1938 through 1942. The results are shown in Table 2.

The No. 1 size corms produced significantly more blooms than did the No. 2's and No. 3's. The former also bloomed earlier and the average size was larger than that from the latter. The data show that for best results No. 1 corms should be planted. They cost more, though, and if transportation is paid by the purchaser it is more than for the smaller sized corms. There was no consistent difference in the production from the No. 2 and No. 3 corms. The four year average showed that the No. 2's gave a few more blooms than the No. 3's, but there was no difference in the average size of blooms. The data show that if the smaller corms are planted a larger number will be required to give the same number of blooms as if No. 1 corms were used. That was because the larger size gave a better stand and had more corms that produced two and three shoots. The blooming season of a given variety of gladiolus may be extended somewhat by planting different sizes of corms at the same time. If No. 2 or No. 3 corms are obtained care should be taken, if possible, to be sure that the smaller size is not due to disease.

TABLE 2. Effect of Size of Corm Planted on Number of Blooms and Size of Plants.

YEAR GROWN	NO. OF BLOOMS PRODUCED			AVE. HEIGHT OF PLANT			AVE. NO. OF FLORETS		
	No. 1	No. 2	No. 3	No. 1 cm.	No. 2 cm.	No. 3 cm.	No. 1	No. 2	No. 3
1938	126	96	..	108.9	76.9	....	15.1	10.9	....
1939	145	97	90	121.0	107.4	110.5	15.7	13.9	13.9
1940	110	88	65	99.5	93.1	93.0	13.4	12.2	11.9
1941	161	71	84	104.8	102.1	102.1	13.9	13.6	13.5
1942	115	94	81						
	143	88	80	108.4	100.9	101.9	14.3	13.2	13.1
	(4 yr. ave. 1939-1942)			(3 yr. ave. 1939-1941)			(3 yr. ave. 1939-1941)		

TABLE 3. Number of Blooms Produced From the Corms that Came From 100 Each of No. 1, No. 2, and No. 3 New Corms.

Year corms were new	Year grown in La.	From No. 1	From No. 2	From No. 3
1941	2nd	327	82	137
	3rd	187	66	54
1942	2nd	114	50	74

To determine the comparison of Nos. 1, 2, and 3 sized corms for increase, all the corms produced from lots of 100 of each grade planted from new corms in 1941 were kept and planted in 1942 and all that they produced were planted again in 1943. Similar data were obtained from corms in 1943 produced from new corms planted in 1942. The results are shown in Table 3. While the number of blooms for the different years varied considerably the data show clearly that from the standpoint of increase the No. 1 corms were far superior. This might be expected for No. 1 corms produce more double and triple shoots than the smaller ones and unless a shoot is produced no corm can be formed.

No tests were made with extra sized corms, but observations indicate that it is not worth while to pay a premium for sizes larger than good No. 1 corms.

Date of Planting

Young gladiolus plants will stand frost and light freezes without appreciable injury. The plants grow best at moderate temperatures and do not bloom satisfactorily in very hot weather. For this reason it is well to plant early for best results. Most of the plantings here reported were made early, either in the last few days of January or early in February. A March 10 planting of 100 corms each year was made for four years. Comparison of the two times of planting are given in Table 4.

TABLE 4. Number of Blooms and Time of Blooming From Early and Late Planted Corms.

TIME OF PLANTING	Year	Number of blooms	TIME BLOOMS WERE CUT						
			May 1-10	May 11-20	May 21-31	June 1-10	June 11-20	June 21-30	July 1-7
Early........	1938	127	77	36	7	7	0	0	0
March 10......		107	0	0	70	37	0	0	0
Early........	1939	144	0	16	77	31	12	8	0
March 10......		121		0	3	62	44	12	0
Early........	1940	111	0	12	38	30	15	12	4
March 10......		81	0	0	2	40	22	13	6
Early........	1941	158	0	0	59	39	36	24	1
March 10......		118	0	0	0	31	56	28	3

The early planted corms consistently produced more flowers than those planted later. The early plantings produced blooms earlier than the later ones and by making the two plantings the blooming season in quantity was extended. The blooming seasons tended to overlap and it is doubtful if more times of planting in between those used would have been of great value. Later plantings would not likely have been successful since blooms would have opened under unfavorable conditions. Size of blooms was apparently more affected by rainfall and temperature than by date of planting.

Corms from Cormels

Gladiolus varieties are increased mainly from cormels. These are produced in varying quantity and size around the corm. The amount of cormel production and the ease of growing corms from them largely determine the cost of corms of a variety. In this experiment cormels were used for the production of corms for three years. It was thought that corms grown from cormels here would give satisfactory production. The first year cormels were used, some good sized No. 1, very high crowned corms were produced. They were from plants that grew late in the season and did not bloom. Some of them are shown in Fig. 1 in comparison with new No. 1 corms and some grown for one and two years in Louisiana. It was thought that the corms produced by plants grown from the very high crowned corms might not be as flat as those from ordinary No. 1 corms. Some average diameters and heights of corms and diameter/height ratios are given in Table 5. The data show that regardless of the shape of the corms planted those produced by flowering plants under the conditions of this experiment were flat.

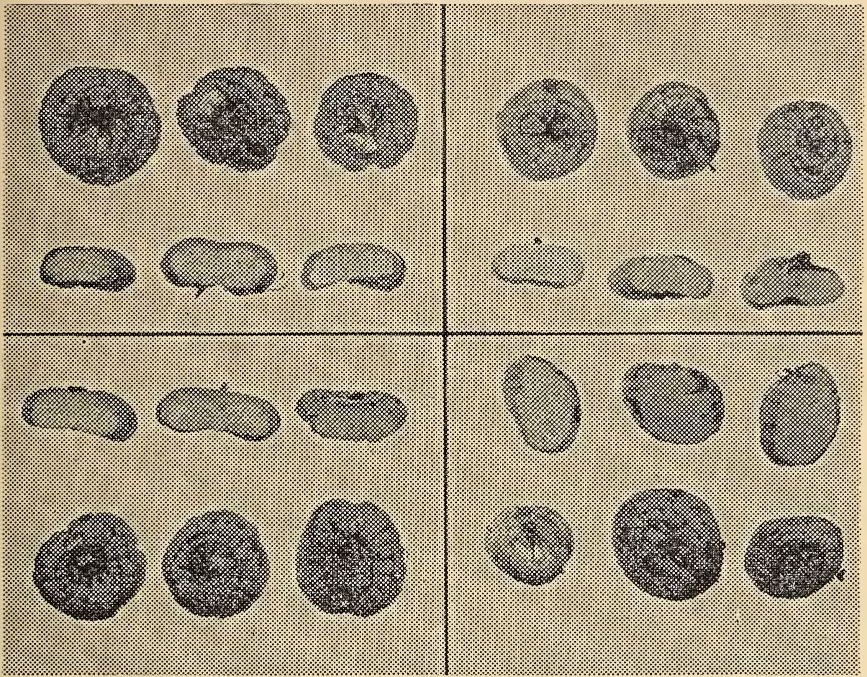

FIGURE 1. Upper right new No. 1 corms from the north. Upper left Louisiana grown one year. Lower right grown from cormels in Louisiana. Lower left Louisiana grown two years.

Plants from many of the larger sized cormels bloomed, but this was not desirable because the corms produced were flat and small. No. 1 corms were easily produced from cormels of the Picardy variety in one season. A few cormels of two other varieties, Minuet and Margaret Fulton, were planted and it took two growing seasons to produce No. 1 corms.

Flowers from corms grown from cormels, especially the Picardy variety, were disappointing. This was partly because large sized corms tended to produce too many shoots with consequent small blooms. Fusarium wilt was present in corms grown from cormels and this of course

TABLE 5. Average diameters and heights and diameter/height ratios of gladiolus corms grown in Louisiana and from the North.

SOURCE OF CORMS	Season grown	Size of corm	Ave. diameter of 100 corms cm.	Ave. height of 100 corms cm.	D/H
Grown in La. from cormels (Very high crowned)	1939	No. 1	4.78	4.08	1.17
Grown in La. from new corms	1939	No. 1	5.58	2.18	2.56
New corms from north	1939	No. 1	5.01	2.17	2.31
Grown 2 yrs. in La.	1940	No. 1	5.80	2.19	2.65
From very high crowned cormels in 1939	1940	No. 1	5.44	2.22	2.45
From new No. 1 in 1939	1940	No. 1	5.55	2.00	2.78
New corms from north	1940	No. 2	3.86	2.14	1.80
Grown in La. from cormels (Very high crowned)	1940	No. 2	3.71	3.08	1.20
From No. 2's new in 1940	1941	No. 1	6.18	2.42	2.55
From very high crowned No. 2 cormels in 1940	1941	No. 1	6.77	2.60	2.60

affected the results obtained. If irrigation were available and the plants could be made to grow and mature corms in the fall, they might be very satisfactory.

Effect of Flowers on the Production of Corms

Cochran and Vereen (1) showed that the production of blooms of Easter lilies affected bulb production and recommended that blooms be removed where lilies are grown for the bulbs. As gladiolus are grown mainly as a cut flower it seemed worthwhile to determine the effect of cutting the blooms on corm production. To get information on this subject new No. 1 corms of the Picardy variety were planted and the following treatments as regards flowers were given: Blooms were not cut; blooms were cut as cut flowers but very little of the foliage except that on the bloom stalk removed; bloom stalks were removed as soon as they appeared without injury to the foliage on the plant. Yield records were kept of number, size, and weight of corms produced. The results of three years are given in Table 6. The data show that when the blooms were kept removed before they opened, the yield of corms was greater than that from the other two treatments. There was no significant difference in yield between plots where blooms were not cut and where they were cut as cut flowers. Fair production of corms was obtained in both cases. The foliage that is left when the bloom is cut produces the corm for the next year, so if most of the plant is removed when the flower is cut, no corm of any size can be expected. Varieties that bloomed late did not produce good sized corms.

Varieties

There are a very large number of varieties of gladiolus of many colors and shades and several different types. Individual preference as to va-

TABLE 6. Corms production from 100 corm lots of gladiolus receiving various bloom stalk treatment.

Year grown	TREATMENT	No. 1		No. 2		No. 3		Cormels Wt. in gms.
		No.	Wt. in gms.	No.	Wt. in gms.	No.	Wt. in gms.	
1938	Flowers uncut............	85	4572	10	234	3	40	758
1939	“ “	91	4192	22	474	4	45	992
1940	“ “	87	3528	6	87	..	....	944
1941	“ “	121	6991	12	254	17	170	1584
	Ave....................	96	4821	12.5	262	6	64	1069
1938	Flowers removed before opening.........	86	5362	6	132	6	60	1087
1939	“ “	106	5723	9	183	8	113	1928
1940	“ “	77	3380	7	125	6	52	659
1941	“ “	127	8241	10	201	15	195	2435
	Ave....................	99	5676	8	160	8.8	105	1527
1938	Cut as cut flowers........	84	4538	8	188	3	36	874
1939	“ “ “ “	98	4596	13	278	8	96	1149
1939	“ “ “ “	75	2769	2	27	4	29	857
1939	“ “ “ “	119	6887	8	189	17	189	1563
	Ave....................	94	4697	7.8	170	8	87	1111

rieties will of course vary. Only a limited number of varieties have been tested in this work and many of these for only one year. Some varieties tend to bloom for a long period while others tend to bloom all at once and are soon gone. Varieties that bloom over a long period might not be as desirable for commercial shipment as those that bloom more or less at one time, but might be better for home yards or for local markets.

Of the varieties tested the Picardy, a large shrimp pink color, is somewhat in a class by itself. Next to Picardy the Maid of Orleans, a fairly large cream white color, is recommended. Minuet, a light lavender color of medium size, comes next. Margaret Fulton, a coral pink color, has done exceptionally well but while its color is excellent it is not an exhibition type and may not be as generally liked as the three varieties named above. It is believed that the above four varieties can be generally recommended in south Louisiana.

The following varieties are considered worthy of trial:

Royal Oak—Yellow with a tinge of pink
Beacon—Showy orange red with light throat
Bagdad—Smoky Rose
Emile Auburn—Rose

A number of other varieties have been grown.

Red: The following red varieties have been tested. Dr. Bennett, Wuertembergia, Red Phipps, Rewi Fallu, Big Red, Bill Sowden, Commander Koehl, and Flaming Sword have been tried. All have produced some beautiful flowers, but none was dependable. Flaming Sword is a primulinus type.

White: Besides Maid of Orleans the following have been tried: Mammoth White—a large beautiful white but falls over too easily; Albania—blooms well but was small; Albatross.

Yellow: No yellow grown was thought to be entirely satisfactory. Miss Bloomington was considered best with Mary Shary next. Golden Eagle bloomed well but was small. Golden Chimes was a light yellow, but was fairly good. Golden Dream was also grown.

The following varieties of various colors have also been tried. Betty Nuthall, Los Angeles, Edith Mason, Charles Dickens, W. H. Phipps, Ave Maria, Knudson, Peggy Lou, Pelligrina, Early Rose, Morocco and Berty Snow.

If individual varieties of gladiolus are to be grown in the home yard, not less than 25 of a kind should be planted and 50 would likely be more satisfactory.

Diseases and Insects

These problems were not studied experimentally and so will not be discussed at length. The most serious disease encountered in this investigation was fusarium wilt. When home grown bulbs were kept in cold storage it was not as serious a problem as when they were kept in common storage. This disease is soil borne as well as being carried on the corm. Gladiolus should not be planted on the same soil year after year. From the behavior of corms during the course of this work, it seemed that disease free corms planted on infested soil gave very good results.

Thrip infestations occurred five years out of seven. Apparently thrips came in on new corms from the North. While no controlled experiments were run, members of the station entomology staff cooperated in observations on thrips. In no case were thrips found to live over the summer. In one instance corms from heavily infested plants were planted without treatment on the same soil and no thrips were found. This is in line with results of Wilson (3) in Florida. In Florida, however, thrips did live on the plants grown in the winter. Where plants were set six inches apart in 3.5 feet rows damage from spread of thrips from sources of infestation was not as severe as in thickly planted beds. The best control of thrips is to plant thrip free corms. For detailed information concerning gladiolus diseases and insects reference is given to U.S.D.A. Farmers' Bulletin No. 1860.

General Recommendations for Growing Gladiolus in South Louisiana

1. Obtain disease and thrip free corms grown where they do not mature in the middle of the summer. No. 1 size of corms is preferable.
2. Get varieties adapted to this area—Picardy, Maid of Orleans, and Minuet have been found to be very satisfactory.

3. Prepare ground well in advance of the time of planting.

4. If planted in rows fertilize similarly to Irish potatoes. On 3½ foot rows apply 4-12-4 fertilizer at the rate of 800 pounds per acre before planting and top dress with 200 pounds of nitrate of soda per acre when the plants come up to a stand. This is at the rate of about 6.5 pounds of 4-12-4 and 1.6 pounds of nitrate of soda per 100 feet of row.

5. Plant corms as early as possible for plants not to be injured by cold when they come up. In south Louisiana early planting should be made the first week of February. Planting after the middle of March is not recommended. Corms should not be set closer than six inches apart in the row and should be covered with three to four inches of soil.

6. Staking and tying will prevent plants falling over, but should not be necessary if corms are planted deep enough and sturdy varieties are grown. Where large numbers of gladiolus are grown staking is almost impossible.

7. Dry weather materially reduces the size of plants and blooms. Gladiolus should be planted where they can be irrigated, if possible. Water thoroughly when it is done.

8. Leave as much foliage as possible when flowers are cut, if corms are to be produced for planting next year. This can be done and blooms still cut with long stems.

9. Dig corms when plants are nearly dead and cut tops off about an inch above the corm. Remove old corms and roots. Place corms at once in a cool, well ventilated place for a week or ten days, then store in cold storage at 40°F. If no cold storage is available continue to store in rather shallow trays in cool, well ventilated dry common storage. Do not allow corms to freeze.

10. Do not plant the same soil to gladiolus oftener than every fourth year. This is a disease control precaution.

11. Best results will be obtained by getting new corms every year if this can be afforded. Then the gladiolus plants may be dug up and removed as soon as flowers are cut. New corms should be obtained at least every third year if they are not gotten every year.

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FINANCIAL RESULTS OF THE OPERATION OF SUGAR MILLS IN LOUISIANA

1939, 1940 AND 1941

by

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FINANCIAL RESULTS OF THE OPERATION OF SUGAR MILLS IN LOUISIANA, 1939, 1940 AND 1941

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INTRODUCTION

A detailed study of the costs and returns from the operations of sugar mills in Louisiana was begun with the 1937 crop year. A previous publication contains a report covering the years 1937 and 1938.[1] The purpose of this report is to present information for the years 1939, 1940 and 1941 and to make comparisons of significant trends for the period. In each of the years the study was limited to mills which manufactured primarily raw sugar. Also the general methods of collecting and analyzing the information were the same each year. Records were collected from 42 mills in 1939, 38 in 1940, and 36 in 1941. There were between 45 and 50 mills in the state each year which manufactured primarily raw sugar. Consequently the sample represents a large proportion of the industry.

The total costs of operating the mills were divided into five main groups, and each group was subdivided into various items.[2] These groupings were very largely determined by the customary practices of the mills in keeping their accounts. However, since these practices varied somewhat between mills, it was necessary to make certain adjustments in the accounts of some of the mills in order to fit them into the arrangement used in this study. Whenever the mills obtained cane from land operated by the company operating the mill, the cost of the cane to the mill was considered to be the amount which would have been paid if the cane had been produced by independent operators. Most of the mills kept their records so as to show the costs in this manner. In cases where they did not do so, appropriate adjustments were made in the records obtained.

The interest cost was calculated at 5 per cent of the total value of the assets used in the business. Interest actually paid for the use of borrowed funds was not included as a cost. This procedure placed all mills on the same basis with respect to capital charges, regardless of the extent of

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[1] Bulletin No. 316 Louisiana Agricultural Experiment Station.

[2] A detailed description of the items included in each group of costs and of the methods of calculating net income is given in Bulletin No. 316 Louisiana Agricultural Experiment Stations, pp. 3 to 5.

TABLE 1. COSTS AND RETURNS FROM THE OPERATION OF SUGAR MILLS IN LOUISIANA, AVERAGE PER MILL, PER TON OF CANE GROUND, AND PER 100 POUNDS OF SUGAR MANUFACTURED, 1939, 1940 AND 1941.

ITEMS OF COST AND RETURN	AVERAGE PER MILL			AVERAGE PER TON OF CANE			AVERAGE PER 100 LBS. OF SUGAR		
	1939	1940	1941	1939	1940	1941	1939	1940	1941
General overhead									
Labor	12,423.94	8,708.02	10,995.28	.16	.20	.18	.10	.12	.11
Materials	1,404.45	888.84	462.23	.02	.02	.01	.01	.01	.01
Taxes	4,421.68	4,121.00	4,846.69	.07	.09	.08	.03	.06	.05
Insurance	5,978.90	4,636.26	6,745.61	.08	.10	.11	.05	.06	.06
Depreciation	14,708.10	14,228.15	14,989.84	.20	.32	.24	.11	.20	.14
Other	2,061.14	2,667.97	3,519.12	.03	.06	.05	.02	.04	.03
TOTAL	40,998.21	35,250.24	41,558.77	.56	.79	.67	.32	.49	.40
Procurement of cane									
Labor	4,134.01	2,297.29	6,749.71	.08	.05	.11	.03	.03	.06
Transportation	24,801.94	13,301.57	17,640.31	.33	.29	.28	.20	.18	.17
Cane purchased	206,303.28	122,779.40	219,760.59	2.78	2.76	3.52	1.59	1.69	2.10
Other	1,142.69	1,159.21	13,335.95	.01	.04	.21	.01	.02	.13
TOTAL	236,381.92	139,537.47	257,486.56	3.20	3.14	4.12	1.83	1.92	2.46
Manufacture of sugar									
Labor	26,201.28	19,922.78	35,554.56	.35	.45	.57	.23	.27	.34
Fuel	6,378.56	5,134.58	5,917.54	.08	.12	.10	.05	.07	.06
Lime, sulphur, etc.	1,526.53	697.87	1,064.22	.02	.02	.02	.01	.01	.01
Bags and twine	5,338.07	3,899.92	4,540.07	.07	.09	.07	.04	.05	.04
Laboratory supplies	409.99	456.18	264.48	.01	.01	*	.01	.01	*
Other supplies	2,552.08	2,105.92	2,219.88	.03	.05	.04	.02	.03	.02
Repairs—labor	10,836.31	9,865.79	4,729.37	.15	.22	.08	.08	.14	.05
Repairs—material	12,136.56	11,010.10	7,774.13	.16	.24	.12	.09	.15	.07
Other	2,858.80	1,946.71	6,548.04	.05	.04	.10	.02	.03	.06
TOTAL	68,238.18	55,039.85	68,612.29	.92	1.24	1.10	.52	.76	.65

*Less than 0.005.

TABLE 1. *(Continued)* COSTS AND RETURNS FROM THE OPERATION OF SUGAR MILLS IN LOUISIANA, AVERAGE PER TON OF CANE GROUND, AND PER 100 POUNDS OF SUGAR MANUFACTURED, 1939, 1940 AND 1941.

ITEMS OF COST AND RETURN	AVERAGE PER MILL			AVERAGE PER TON OF CANE			AVERAGE PER 100 LBS. OF SUGAR		
	1939	1940	1941	1939	1940	1941	1939	1940	1941
Selling									
Commission	4,205.99	1,866.13	2,767.25	.06	.04	.04	.03	.03	.03
Weighing and gauging	974.63	260.74	387.44	.01	.01	.01	.01	*	*
Storage	1,189.76	672.32	172.93	.01	.02	*	.01	.01	*
Freight and drayage	11,839.59	4,629.50	4,989.98	.16	.10	.08	.09	.06	.05
Other	988.36	516.55	1,149.07	.01	.01	.02	.01	.01	.01
TOTAL	19,208.33	7,945.24	9,466.67	.25	.18	.15	.15	.11	.09
Interest	16,492.90	17,549.65	20,017.98	.22	.39	.32	.13	.24	.19
TOTAL COST	381,319.54	255,322.45	397,142.27	5.15	5.74	6.36	2.95	3.52	3.79
Miscellaneous credits	33,404.10	25,266.64	109,200.55	.45	.57	1.75	.26	.35	1.04
Net cost	347,915.44	230,095.81	287,941.72	4.70	5.17	4.61	2.69	3.17	2.75
Receipts									
Raw sugar	371,306.53	214,181.31	331,896.60	5.01	4.82	5.31	2.87	2.95	3.17
Miscellaneous receipts									
Other sugar	3,730.27	755.00	32,629.67	.05	.02	.52	.03	.01	.31
Syrup	1,524.34	3,217.26	7,336.44	.02	.07	.12	.01	.04	.07
Molasses	23,031.18	17,243.78	61,734.24	.31	.39	.99	.18	.24	.59
Other	5,118.31	4,010.60	7,500.20	.07	.09	.12	.04	.06	.07
TOTAL MISCELLANEOUS	33,404.10	25,226.64	109,200.55	.45	.57	1.75	.26	.35	1.04
Total receipts	404,710.63	239,407.95	441,097.15	5.46	5.39	7.06	3.13	3.30	4.21
Operating expenses	364,826.70	237,772.80	377,124.29	4.93	5.35	6.04	2.82	3.28	3.60
Net operating income	39,883.93	1,635.15	63,972.86	.53	.04	1.02	.31	.02	.61
Net income	23,391.09	−15,914.50	43,954.88	.31	−.35	.70	.18	−.22	.42
Capital investment	329,856.85	350,993.08	406,470.77	4.46	7.89	6.51	2.55	4.83	3.88
Cane ground—mill tons	74,028.40	44,447.40	62,455.94	......	......	......	.57	.61	.60
Sugar made—pounds	12,792,355.00	7,267,582.00	10,487,408.00	174.49	163.51	167.90	......	......	......

*Less than 0.005.

their borrowings or the rate of interest actually paid. The use of 5 per cent in calculating interest was largely arbitrary. The effect of using a different rate can be determined by applying the desired rate to the capital investment given in the tables.

Average Costs and Returns

The average financial results of the operation of the mills in 1939, 1940 and 1941 are shown in Table 1. In general the three years were very different. In 1939 and 1941 the average net income of the mills was satisfactory, while in 1940 serious losses were suffered. Apparently the most important reasons for this marked difference were the smaller number of tons of cane ground and the lower yield of sugar per ton of cane in 1940. The number of tons of cane ground per mill was approximately 35 per cent lower in 1940 than the average of 1939 and 1941. The number of pounds of sugar manufactured was nearly 38 per cent lower. No doubt other factors, such as changes in wage rates and the prices of materials used by the mills, had some influence on the difference in the results obtained in each year, but their effect was of minor importance only.

The effect of reduced volumes on costs was quite different for some items than it was for others. The average total cost per mill was $133,908.45 or 34 per cent lower in 1940 than the average of 1939 and 1941. Interest costs increased slightly each year. General overhead costs were only 15 per cent and the costs of manufacturing sugar 20 per cent lower in 1940 than the average of the other two years. In contrast to this, procurement costs declined 43 per cent and selling costs 45 per cent. In other words some of the costs remained at approximately the same amount per mill in spite of the decreased volume of product handled, while other costs declined in about the same proportion as the decline in volume. In particular such costs as interest, depreciation, repairs, insurance, and taxes are relatively fixed in amount regardless of yearly variations in the volume of business. Certain other costs, such as the purchase of cane and charges for selling sugar, are largely set at certain amounts per unit of raw material or finished product and consequently vary closely with variations in volume. Selling costs per mill declined even more than volume did from 1939 to 1940. Apparently this was caused by certain changes in selling practices made by some of the mills.

The costs of operating sugar mills can be measured in terms of cost per unit of business done. Table 1 shows such costs in two ways; one as average cost per ton of cane ground and the other as average per 100 pounds of sugar manufactured. The relative behavior of these unit costs in the years studied was quite different from the behavior of average costs per mill. The total cost per ton of cane ground was approximately the same in 1940 as the average of the other two years while cost per 100 pounds of sugar was 4 per cent higher. Increases in unit costs in 1940 occurred in general overhead, manufacture of sugar and interest.

Selling costs per unit actually declined, while the unit costs of procuring cane were highest in 1941. The high costs in 1940 were largely caused by the fixed costs which could not be reduced in amount when the volume of business of the mills declined.

The average gross receipts per mill declined 41 per cent from 1939 to 1940 but were 9 per cent higher in 1941 than in 1939. The decline in 1940 was entirely the result of a decline in the volume of product handled, since the gross income per ton declined only 1.3 per cent from 1939 to 1940, while the income per 100 pounds of sugar increased 5.4 per cent. The prices obtained for sugar and other prdoucts sold by the mills were, in general, slightly better in 1940 than in the previous year. They were still higher in 1941. The greatest increase in prices occurred in the price of molasses in 1941.

Geographic Variations

It is commonly recognized that there are important differences in the conditions under which sugar mills operate in various parts of the sugar producing area of Louisiana. In an attempt to study the effect of these differences on financial returns, the mills were divided into two groups. One group, in what is called the Teche region, includes all of the mills located west of the Atchafalaya River. The other group, in the Mississippi region, includes all of the mills east of the Atchafalaya River. Not all of the important geographic differences are revealed by this division. However, the number of mills included in the study is so small that it is not feasible to use smaller regions.

The total cost per 100 pounds of sugar manufactured was lower in the Teche than in the Mississippi region in 1939 and 1940, but it was higher in 1941 (Table 2). Most of the differences in costs were not large. In 1939 and 1940 the most important differences were in the cost of manufacturing sugar and in 1941 in the cost of cane to the mills.

The receipts of the mills from the sale of sugar and from other sources were practically the same for both regions in 1939. In 1940 the receipts of the Teche mills, per 100 pounds of sugar manufactured, were slightly larger than they were in the Mississippi region, while in 1941 they were lower. The greatest difference in 1941 was in receipts from miscellaneous sources. Receipts from the sale of molasses account for the larger part of the miscellaneous receipts.

Both net operating income and net income were higher, or losses lower, in 1939 and 1940 for mills in the Teche region than they were for those in the Mississippi region. In 1941 the situation was reversed and the mills in the Mississippi region obtained the largest net income. The reasons for the shift in 1941 are not entirely clear. In each of the three years the average yield of sugar per ton of cane ground was higher in the Teche than in the Mississippi region. Also the capital invested, per 100 pounds of sugar manufactured, was slightly lower each year in the Teche than in the Mississippi region.

TABLE 2. GEOGRAPHIC VARIATIONS IN THE FINANCIAL RESULTS OBTAINED FROM THE OPERATION OF SUGAR MILLS IN LOUISIANA, 1939, 1940, AND 1941.

ITEMS OF COST AND RETURN	AVERAGE PER 100 POUNDS OF SUGAR MANUFACTURED					
	1939		1940		1941	
	Miss. region	Teche region	Miss. region	Teche region	Miss. region	Teche region
General overhead	$ .32	$ .31	$ .51	$ .46	$ .39	$ .40
Procurement of cane	1.84	1.82	1.93	1.91	2.41	2.52
Manufacture of sugar	.58	.48	.77	.74	.65	.66
Selling	.16	.14	.11	.11	.08	.10
Interest	.14	.12	.24	.24	.20	.18
TOTAL COST	3.04	2.87	3.56	3.46	3.73	3.86
Miscellaneous credits	.26	.26	.36	.33	1.32	.72
Net cost	2.78	2.61	3.20	3.13	2.41	3.14
Receipts from:						
Raw sugar	2.88	2.87	2.90	3.00	3.03	3.32
Miscellaneous sources	.26	.26	.36	.33	1.32	.72
TOTAL	3.14	3.13	3.26	3.33	4.35	4.04
Operating expenses	2.90	2.75	3.32	3.22	3.53	3.68
Net operating income	.24	.38	–.06	.11	.82	.36
Net income	.10	.26	–.30	–.13	.62	.18
Capital investment	2.84	2.31	4.94	4.71	4.07	3.64
Pounds of sugar produced per ton of cane ground	170.90	177.70	159.50	168.10	164.90	171.60

Relation of Size of Mills to Financial Results

The relationship between the size or capacity of a sugar mill and the financial results that might be obtained from its operation is one of great importance to the industry. There has been a tendency, over a long period of years, for the number of sugar mills in Louisiana to decrease and for their average size to increase. Technical progress in the manufacture of sugar seems to have been largely responsible for this trend. The data collected in this study are helpful in obtaining an understanding of the significance of size in relation to financial returns, although many factors other than those considered in this study are of importance in this connection.

Table 3 shows, for each of the three years, the relationship between the capacity of the mills, in tons of cane which could be ground per 24 hours, and the costs of operating the mills per 100 pounds of raw sugar manufactured. In 1939 and 1941 the costs decreased as the capacity of the mills increased. The decline was largest in 1941 when the average net income of all of the mills was highest. In 1940, when the average mill lost money, the costs were actually higher for the mills with the largest capacity than they were for the smallest mills. The greatly reduced tonnage of cane ground in 1940 apparently had more adverse effect on the large mills than it did on the small ones. Interest and overhead costs are largely fixed in amount per mill regardless of yearly variations in the size of the crop. Since the tonnage ground declined more in 1940 for the large mills than it did for the small ones, the fixed costs per 100 pounds of sugar made tended to increase more. This appears to be the explanation of the reverse relationship between capacity and unit costs existing in 1940.

TABLE 3. Relation Between the Capacity of Sugar Mills and the Cost, Per 100 Pounds, of Operating Raw Sugar Mills in Louisiana, 1939, 1940 and 1941

Capacity of mills in tons per 24 hours	Number of mills	Costs per 100 pounds of raw sugar					
		Total Cost	General overhead	Procurement of cane	Manufacture of sugar	Selling	Interest
1939—Under 1000. . .	9	$ 3.00	$ .28	$ 1.86	$ .57	$ .19	$ .10
1,000 to 1,499.	18	3.06	.33	1.86	.57	.17	.14
1,500 and over	15	2.88	.32	1.82	.50	.12	.12
All mills. .	42	2.95	.32	1.83	.52	.15	.13
1940—Under 1,000. .	6	3.40	.46	1.86	.75	.18	.15
1,000 to 1,499.	17	3.60	.52	1.90	.83	.11	.24
1,500 and over	15	3.48	.47	1.94	.71	.10	.26
All mills. .	38	3.52	.49	1.92	.76	.11	.24
1941—Under 1,000. .	8	3.98	.35	2.68	.71	.12	.12
1,000 to 1,499.	12	3.93	.38	2.55	.67	.11	.22
1,500 and over	16	3.68	.41	2.36	.64	.07	.20
All mills. .	36	3.79	.40	2.46	.65	.09	.19

The principal advantage of the large mills in obtaining lower costs appears to have been in connection with the costs of manufacture and selling expenses. Each year, including even 1940, these costs were lower for the large mills than they were for the small ones. In 1939 manufacturing costs were 12 per cent lower for the large than for the small mills. In 1940 the difference was 5 per cent and in 1941 it was 10 per cent. The decline in selling costs amounted to 37 per cent in 1939, 44 per cent in 1940, and 42 per cent in 1941. Interest and overhead costs were generally higher for large mills than they were for small ones.

The relationship between the capacity of sugar mills and the income received per 100 pounds of sugar manufactured is shown in Table 4. In general there was no consistent relationship between the total receipts of the mills and their capacity. However, both the net income and the net operating income per 100 pounds of sugar were greater for the large mills than for the small ones in 1939 and 1941. In 1940 the mills with the smallest capacity had better net incomes than any of the other groups. The same factors that influenced the relationship of size to cost also appear to have been responsible for the relationship between size and net income.

TABLE 4. Relation Between the Capacity of Sugar Mills and the Income, Per 100 Pounds, From the Operation of Raw Sugar Mills in Louisiana, 1939, 1940, and 1941.

Capacity of mills in tons per 24 hours	Number of mills	Income per 100 pounds of raw sugar				
		Total receipts	Receipts from sugar	Other receipts	Net operating income	Net income
1939—Under 1,000	9	$ 3.16	$ 2.91	$ .25	$ .27	$ .17
1,000 to 1,499	18	3.15	2.90	.25	.23	.09
1,500 and over	15	3.11	2.85	.26	.35	.23
All mills	42	3.13	2.87	.26	.31	.18
1940—Under 1,000	6	3.45	3.10	.35	.20	.05
1,000 to 1,499	17	3.21	2.90	.31	−.15	−.39
1,500 and over	15	3.32	2.95	.37	.10	−.16
All mills	38	3.30	2.95	.35	.02	−.22
1941—Under 1,000	8	4.32	3.27	1.05	.46	.34
1,000 to 1,499	12	4.41	3.51	.90	.70	.48
1,500 and over	16	4.08	2.98	1.11	.60	.40
All mills	36	4.21	3.17	1.04	.61	.42

Part of the decreased costs and increased net income can be attributed to the greater technical efficiency which the larger mills apparently possessed. For instance, Table 5 shows that the number of pounds of sugar manufactured per ton of cane increased as the size of the mills increased in both 1939 and 1941. In 1940 it decreased slightly. The reason for the lower recovery of sugar by the large mills in 1940 is not clear. The quality of the cane, as indicated by the percent of sucrose it contained was about the same each year for the various sizes of mills.

The percentage of the sucrose originally present in the cane which was recovered in sugar was slightly greater for the large than for the small mills in 1939 and 1941 and slightly smaller in 1940. The difference was greatest in 1939 when the quality of the cane ground was apparently somewhat better than in the other two years and the recovery of sugar per ton of cane was the largest for the three-year period.

Relation of Volume of Cane Ground to Financial Results

The number of tons of cane ground by a sugar mill in any season is, of course, closely related to the size of the mill. However, the rela-

TABLE 5. Relation Between the Capacity of Louisiana Sugar Mills and Their Average Volume of Business and Technical Efficiency, 1939, 1940, and 1941.

Capacity of Mills in tons per 24 hours	Number of mills	Pounds of raw sugar made	Tons of cane ground	Pounds of sugar per ton cane	Days of capacity grinding	Per cent sucrose in cane	Per cent of sucrose recovered in sugar
1939—Under 1,000....	9	6,936,474	40,949	169.4	54.2	10.6	75.9
1,000 to 1,499...	18	11,783,435	67,918	173.5	58.6	10.3	79.7
1,500 and over..	15	17,866,364	101,208	176.5	54.8	10.3	80.8
All mills...	42	12,917,332	74,028	174.5	56.2	10.4	79.7
1940—Under 1,000....	4	3,865,152	23,632	163.6	27.8	9.1	81.5
1,000 to 1,499...	13	5,857,462	35,817	163.5	31.1	10.0	78.4
1,500 and over..	15	10,001,203	61,485	162.7	33.2	9.8	78.9
All mills...	32	7,500,848	35,296	163.0	32.1	9.8	78.9
1941—Under 1,000....	8	5,991,402	36,346	164.8	46.1	10.1	79.8
1,000 to 1,499...	12	8,812,011	52,466	168.0	43.8	9.4	81.3
1,500 and over..	16	13,991,958	83,003	168.6	45.3	10.0	81.0
All mills...	36	10,487,407	62,456	167.9	45.0	9.9	80.9

tionship is by no means perfect, since some mills operate at more nearly maximum capacity or for a greater number of days than do others.Table 6 shows the relationship between the number of tons of cane ground

TABLE 6. Relation Between the Volume of Cane Ground and the Average Costs Per 100 Pounds of Raw Sugar Manufactured by Louisiana Mills, 1939, 1940 and 1941.

Tons of cane ground	Number of mills	Costs per 100 pounds of raw sugar					
		Total	General overhead	Procurement of cane	Manufacture of sugar	Selling	Interest
1939—Under 50,000...	10	$ 3.30	$ .30	$ 1.89	$ .59	$ .19	$ .11
50,000 to 74,999.	12	3.03	.31	1.87	.54	.18	.13
75,000 to 99,999.	13	2.94	.30	1.83	.54	.14	.13
100,000 and over.	7	2.89	.36	1.81	.48	.12	.12
All mills...	42	2.95	.32	1.83	.52	.15	.13
1940—Under 30,000...	9	3.58	.53	1.90	.81	.14	.20
30,000 to 49,999.	17	3.50	.47	1.92	.76	.12	.23
50,000 and over.	12	3.49	.48	1.92	.74	.09	.26
All mills...	38	3.52	.49	1.92	.76	.11	.24
1941—Under 50,000...	14	4.07	.40	2.66	.69	.13	.19
50,000 to 74,999.	12	3.79	.32	2.54	.65	.09	.19
75,000 and over.	10	3.63	.46	2.27	.63	.07	.20
All mills...	36	3.79	.42	2.46	.65	.09	.19

and the cost per 100 pounds of sugar manufactured. For each of the three years the total costs declined as the number of tons of cane ground increased. In 1939 the difference in total cost between the mills grinding the smallest number of tons and those grinding the largest amounted to 19 cents per 100 pounds of sugar. This is equal to 6.2 per cent of the cost incurred by the small tonnage mills. In 1940 the difference was only 9 cents per 100 pounds of sugar or 2.5 per cent, while in 1941 the figures were 44 cents and 10.8 per cent.

Most of the reduction in unit costs with increased tonnages occurred in the selling costs and in the costs of manufacturing. Interest costs were practically constant regardless of the amount of cane ground in 1939 and 1941. In 1940 interest costs per 100 pounds of sugar increased as the tonnage ground increased. Apparently for most years the investment in a sugar mill increases about in proportion to the tonnage of cane handled, but in 1940 with a short crop the investment per ton was higher for the mills that handled the most cane.

TABLE 7. RELATION BETWEEN THE VOLUME OF CANE GROUND AND THE INCOME PER 100 POUNDS OF SUGAR MANUFACTURED BY MILLS IN LOUISIANA, 1939, 1940 AND 1941

TONS OF CANE GROUND	Number of mills	INCOME PER 100 POUNDS OF RAW SUGAR				
		Total receipts	Receipts from sugar	Other receipts	Net operating income	Net income
1939—Under 50,000	10	$ 3.14	$ 2.85	$ .29	$ .17	$ .06
50,000 to 74,999	12	3.13	2.87	.26	.23	.10
75,000 to 99,999	13	3.09	2.85	.27	.28	.15
100,000 and over	7	3.25	2.98	.27	.48	.36
ALL MILLS	42	3.13	2.87	.26	.31	.18
1940—Under 30,000	9	3.31	3.03	.28	−.07	−.27
30,000 to 49,999	17	3.28	2.92	.36	.01	−.22
50,000 and over	12	3.29	2.94	.35	.06	−.20
ALL MILLS	38	3.30	2.95	.35	.02	−.22
1941—Under 50,000	14	4.23	3.32	.91	.35	.16
50,000 to 74,999	12	4.40	3.50	.90	.80	.61
75,000 and over	10	4.04	2.81	1.23	.61	.41
ALL MILLS	36	4.21	3.17	1.04	.61	.42

The net income of the sugar mills increased, or the losses declined, each year as the amount of cane ground increased (Table 7). In 1939 the difference in net income between the mills with the lowest tonnage and those with the highest amounted to 30 cents per 100 pounds of sugar, in 1941 it was 25 cents, while in 1940 the losses were 7 cents lower for the large tonnage mills. These differences are large enough to be of great importance to the financial prosperity of a mill, especially since the same mills are likely to handle small or large tonnages year after year.

In each of the three years the mills which ground the largest amount of cane had a slightly longer operating season than did the mills with the smallest tonnages (Table 8). In 1939 the difference amounted to 7.3 days which is equivalent to a 14.4 per cent increase in the length of time the small tonnage mills operated. In 1940 the differences amounted to 9.8 days or 39.0 per cent and in 1941 to 6.4 days or 15.8 per cent. The short grinding season, which causes the investment in sugar mills to be idle most of the year, has always constituted an unfavorable condition for the Louisiana sugar industry as compared with similar industries in the tropics. Apparently some of the mills have succeeded better than others is lengthening their grinding season somewhat. Usually these have been the mills with the largest grinding capacity, and also those with the lowest unit costs and largest net incomes.

TABLE 8. The Relation Between the Volume of Cane Ground and the Average Amount of Sugar and Technical Efficiency of Louisiana Sugar Mills, 1939, 1940 and 1941.

Tons of cane ground	Number of mills	Pounds of raw sugar made	Days of capacity grinding	Capacity of mills in tons per 24 hours	Pounds of raw sugar per ton of cane	Per cent of sucrose recovered in sugar
1939—Under 50,000	10	6,731,073	50.7	795	167.1	77.3
50,000 to 74,999	12	10,935,943	54.2	1,179	171.2	77.4
75,000 to 99,999	13	14,619,021	58.5	1,413	176.7	80.2
100,000 and over	7	21,991,235	58.0	2,129	178.0	82.5
All mills	42	12,917,332	56.1	1,319	174.5	79.7
1940—Under 30,000	7	3,885,706	25.1	943	164.1	80.1
30,000 to 49,999	13	6,451,900	31.1	1,288	160.9	78.0
50,000 and over	12	10,879,377	34.9	1,900	164.1	79.3
All mills	32	7,550,849	32.1	1,442	163.0	78.9
1941—Under 50,000	14	6,497,053	40.5	964	166.4	80.4
50,000 to 74,999	12	10,693,507	46.2	1,380	167.5	80.4
75,000 and over	10	15,926,585	46.9	1,995	170.2	81.5
All mills	36	10,487,407	45.0	1,390	167.9	80.9

The number of pounds of raw sugar obtained per ton of cane ground was larger for the large tonnage mills than it was for the other mills, in both 1939 and 1941. In 1940 there was very little difference except that the yield was lowest for the median group of mills. There appears to be some relationship between the yield of sugar obtained and the proportion of the total sucrose in the cane which was recovered in the form of sugar. This percentage was higher for the large tonnage mills than for those with small tonnages, except in 1940. Variations in the yield of sugar per ton of cane are affected by the technical efficiency of the mills and by the sucrose content of the cane ground. Apparently the mills with the larger tonnages were usually the most efficient in extracting sugar. Although the data are not shown in Table 8, there were only slight differences in the sucrose content of the cane ground by the various groups of mills.

Relation of Yield of Sugar to Financial Results

The number of pounds of sugar obtained per ton of cane ground has always been an important factor influencing the financial success of a sugar mill. Table 9 shows the relationship between the yield of sugar and the costs per 100 pounds of sugar manufactured. In each of the three years there was a general tendency for the costs to decline as the number of pounds of sugar obtained from a ton of cane increased. The relationship was somewhat irregular, especially in 1940, but the mills with the highest yields always had lower costs than did those with the lowest yields.

TABLE 9. RELATION BETWEEN THE YIELD OF SUGAR OBTAINED PER TON OF CANE AND THE AVERAGE COSTS, PER 100 POUNDS OF RAW SUGAR MANUFACTURED, OF OPERATING SUGAR MILLS IN LOUISIANA, 1939, 1940 AND 1941

POUNDS OF RAW SUGAR PER TON OF CANE	Number of mills	COSTS PER 100 POUNDS OF RAW SUGAR					
		Total cost	General overhead	Procurement of cane	Manufacture of sugar	Selling	Interest
1939—Under 150......	2	$ 3.72	$ .38	$ 2.15	$ .70	$ .32	$ .17
150 to 159.9....	0	....	....	....	....	....	....
160 to 169.9....	15	3.10	.32	1.94	.55	.17	.12
170 to 179.9....	15	2.93	.34	1.75	.56	.15	.13
180 and over....	10	2.75	.27	1.80	.44	.11	.13
ALL MILLS...	42	2.95	.32	1.83	.52	.15	.13
1940—Under 150......	4	3.91	.53	2.15	.80	.10	.33
150 to 159.9....	9	4.06	.57	2.21	.93	.10	.25
160 to 169.9....	19	3.43	.46	1.88	.79	.09	.21
170 to 179.9....	3	3.17	.38	1.85	.65	.15	.14
180 and over....	3	3.49	.57	1.83	.54	.20	.35
ALL MILLS...	38	3.52	.49	1.92	.76	.11	.24
1941—Under 160......	5	4.14	.36	2.67	.73	.18	.20
160 to 169.9....	18	3.65	.39	2.43	.60	.06	.17
170 and over....	13	3.85	.41	2.43	.70	.10	.21
ALL MILLS...	36	3.79	.40	2.46	.65	.09	.19

The principal reductions in cost which accompanied an increased yield of sugar were in the manufacturing costs and the costs of procuring cane. The price which mills pay for cane varies according to its sugar content and probably was somewhat higher per ton for the mills with the higher yields of sugar than for those with lower yields. However, this difference was not enough to entirely offset the influence of the larger number of pounds of sugar obtained, so that costs per 100 pounds still decreased as sugar yields increased. The decreasing costs of manufacture with increasing yields was probably the result of greater technical efficiency in the operation of the larger mills which were the ones obtaining the higher yields.

TABLE 10. RELATION BETWEEN THE YIELD OBTAINED PER TON OF CANE AND THE INCOME PER 100 POUNDS OF RAW SUGAR MANUFACTURED BY MILLS IN LOUISIANA, 1939, 1940, AND 1941.

POUNDS OF RAW SUGAR PER TON OF CANE	Number of mills	INCOME PER 100 POUNDS OF RAW SUGAR				
		Total receipts	Receipts from sugar	Other receipts	Net operating income	Net income
1939—Under 150	2	$ 3.51	$ 2.99	$ .52	$ −.04	$ −.21
150 to 159.9	0	....	....	....	....	....
160 to 169.9	15	3.22	2.91	.31	.24	.12
170 to 179.9	15	3.08	2.84	.24	.28	.15
180 and over	10	3.08	2.88	.21	.46	.34
ALL MILLS	42	3.13	2.87	.26	.31	.18
1940—Under 150	4	3.50	2.86	.64	−.09	−.41
150 to 159.9	9	3.67	3.33	.34	−.14	−.39
160 to 169.9	19	3.26	2.92	.34	.04	−.17
170 to 179.9	3	3.20	2.98	.22	.17	.03
180 and over	3	3.44	3.18	.26	.30	−.05
ALL MILLS	38	3.30	2.95	.35	.02	−.22
1941—Under 160	5	4.46	3.24	1.22	.52	.32
160 to 169.9	18	4.24	3.04	1.20	.76	.59
170 and over	13	4.09	3.29	.80	.45	.24
ALL MILLS	36	4.21	3.17	1.04	.61	.42

Both the net income and the net operating income per 100 pounds of sugar was larger for the mills with a high yield of sugar than it was for those with a low yield (Table 10). This relationship was very consistent between the different groups of mills in 1939 and 1940. However, in 1941 the mills with the highest yields did not have the highest net income. This was largely caused by the fact that the "other receipts" per 100 pounds of sugar, which includes receipts from the sale of molasses rose very rapidly during the early part of the season and mills obtained widely varying prices for their molasses depending upon the time of sale.

The relationship between net income and yield of sugar was very largely determined by the relationship between cost and yield. There was no consistent relationship between the receipts of the mills and the yield of sugar which they obtained, although there was considerable variation between the groups each year.

In 1939 and 1941 the mills with the highest yield of sugar were those with the largest grinding capacity and also those which produced the largest total number of pounds of sugar. In 1940, when the cane crop was unusually poor, the relationship between yield and size was inconsistent for the various groups of mills (Table 11).

TABLE 11. THE RELATION BETWEEN THE YIELD OF SUGAR AND THE AVERAGE VOLUME OF BUSINESS, CAPACITY AND TECHNICAL EFFICIENCY OF LOUISIANA SUGAR MILLS, 1939, 1940 AND 1941.

POUNDS OF RAW SUGAR PER TON OF CANE	Number of mills	Pounds of raw sugar made	Tons of cane ground	Capacity mills in tons per 24 hours	Days of capacity grinding	Per cent sucrose in cane	Per cent of sucrose recovered in sugar
1939—Under 150......	2	6,637,188	48,188	850	56.7	9.6	67.2
150 to 159.9....	0	....	......	......	....	....	....
160 to 169.9....	15	11,191,768	68,076	1,247	54.6	10.1	77.6
170 to 179.9....	15	14,197,065	79,424	1,413	56.2	10.4	80.6
180 and over....	10	14,842,109	80,032	1,378	58.1	10.7	82.5
ALL MILLS...	42	12,917,332	74,028	1,318	56.1	10.4	79.7
1940—Under 150......	3	8,635,864	58,617	1,567	37.4	9.9	71.3
150 to 159.9....	9	7,030,155	44,847	1,378	32.6	9.6	77.8
160 to 169.9....	17	7,052,203	42,571	1,397	30.5	9.8	80.3
170 to 179.9....	0	....	......	......	....	....	....
180 and over....	3	10,853,471	59,419	1,767	33.8	10.5	83.1
ALL MILLS...	32	7,550,849	46,326	1,442	32.1	9.8	78.9
1941—Under 160......	5	8,305,027	53,925	1,230	43.8	9.8	78.1
160 to 169.9....	18	10,284,776	62,119	1,319	47.1	9.5	80.7
170 and over....	13	11,531,198	66,204	1,548	42.8	10.3	81.9
ALL MILLS...	36	10,487,407	62,456	1,390	45.0	9.9	80.9

The relatively low yields obtained by the small mills seem to have been partly the result of grinding cane containing a slightly smaller percentage of sucrose than that ground by the mills obtaining higher yields. This was true in each of the three years if the comparison is made between the group of mills with the lowest and the group with the highest yields. However, the relationship was not consistent for the middle groups of mills except in 1939.

A more important factor favoring high yields of sugar was the better extraction obtained by the larger mills. In 1939 the proportion of the sucrose present in the cane which was recovered in sugar varied from 67.2 per cent to 82.5 per cent. In the other years the variation was less but still large enough to be significant. For instance, in 1939 the difference between the lowest and highest groups in the per cent of sucrose recovered was equivalent to 26.6 pounds of 96° sugar per ton of cane. In 1940 the difference was equivalent to 22.2 pounds and in 1941 to 5.8 pounds.

SUMMARY

A study of the financial results obtained from the operation of Louisiana sugar mills during the three-year period 1939 to 1941 shows that expenses and profits have varied widely. An unusually short crop of cane for grinding in 1940 was the most important cause of the high expenses per unit of product and the sizeable losses sustained by the mills that year. Unit costs were even higher in 1941 than in 1940. However, this was primarily the result of a higher price paid for cane and under the terms of the Louisiana cane purchase contract the price of cane varies directly with the price of sugar. Consequently the mills, in 1941, received enough for their sugar to enable them to meet their high expenses and still have some profit.

Various factors appeared to be more or less closely related to the variations in costs and returns which existed each year between different sugar mills. For instance, the mills in the Teche region had the lower unit costs and higher net incomes in 1939 and 1940 than did those in the Mississippi region. In 1941, this situation was reversed.

The size of a sugar mill and the volume of cane which it grinds are directly related to unit costs and returns. In general costs per unit of product were lower for the larger than they were for the smaller mills, although this was not true in 1940 when the tonnage of cane ground was unusually small for all sizes of mills. These lower costs seem to have been partly the result of greater technical efficiency in extracting sucrose from sugar cane. However, a considerable part of the difference appears to be the result of a more effective use of labor and materials in manufacturing and selling sugar. This is shown by the consistent decline in these costs as the size of the mills increased.

The number of tons of cane ground by a mill is closely related to its grinding capacity but is not entirely controlled by this factor, since some mills operate for a longer season or more nearly at their maximum capacity than do others. During each of the three years 1939 to 1941, the mills grinding the largest tonnage of cane had more days of capacity grinding than did the mills with small tonnages. They were also the mills with the largest grinding capacity and the highest percentage recovery of sucrose. In general the greater amount of cane ground the lower were the costs per 100 pounds of sugar manufactured and the higher the net income received.

Each year certain mills obtained a considerably larger number of pounds of sugar per ton of sugar cane ground than did other mills. These differences were the result of grinding cane with a higher sucrose content and of obtaining a better recovery of sucrose in the form of sugar. In general, the difference in the percentage of the sucrose in cane which was recovered in sugar was a more important factor than the difference in the original sucrose content of the cane. There was a significant tendency for the costs per 100 pounds of sugar manufactured to be lower and net incomes higher for those mills which obtained a high yield of sugar than they were for mills with lower yields.

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FINANCIAL RESULTS OF THE OPERATION OF LARGE SUGAR CANE FARMS IN LOUISIANA, 1939, 1940 AND 1941

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FINANCIAL RESULTS OF THE OPERATION OF LARGE SUGAR CANE FARMS IN LOUISIANA, 1939, 1940 AND 1941

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INTRODUCTION

A detailed study of the financial aspects of operating large sugar cane farms in Louisiana was started with the 1937 crop year. The results of the study for the years 1937 and 1938 have been presented in a previous publication.[1] The purpose of the present report is to present information covering the 1939, 1940 and 1941 crop years and to indicate significant changes which may have occurred during the period. The farms included in the study cover substantially the same group in each of the three years, so that rather detailed comparisons are possible.

The data used in this report were all obtained from the records of the operators of the farms. In all cases detailed financial records were available and were used as a major source of information. Records were obtained from 88 farms in 1939, 90 in 1940 and 76 in 1941. In a number of cases a single individual or company owned and operated more than one farm. The number of separate owners who supplied information was 40 in 1939, 39 in 1940 and 36 in 1941.

Average Costs Per Farm

A summary of the average costs and returns per farm is shown in Table 1. The total costs per acre of cane grown were highest in 1939 and lowest in 1940, while the costs per ton of cane sold were lowest in 1939 and highest in 1940. The average costs per farm resembled costs per acre in being highest in 1939 and lowest in 1940. The unusually low yield of cane per acre in 1940 is the principal cause of the different behavior of costs per acre and costs per ton. With a very poor crop in 1940 only moderate reductions could be made in the total costs of operating of sugar cane farms. Consequently total costs per farm and costs per acre were only about 13 per cent lower in 1940 than in 1939, while costs per ton, because of the greatly reduced tonnage produced, were 36 per cent higher in 1940 than in 1939.

Most of the reduction in the costs per farm and per acre of cane grown occurred in the cost of harvesting. Most of the labor used in harvesting cane is paid on a piece work basis, so much per ton of cane cut. Consequently harvesting costs tend to vary directly with the size of the crop. Harvesting costs per ton were actually lower in 1940 than in 1939, although slightly higher than in 1941. The reduction in harvesting costs over the three-year period appears to have been caused by the increased use of mechanical harvesters each year. Data on the cost of harvesting cane with machines are not available for this study. However, such general information as is available indicates that machine harvesting costs considerably less per ton than hand harvesting.

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[1] Bulletin No. 315, Louisiana Agricultural Experiment Station.

General overhead costs per farm and per acre of cane remained approximately constant over the three-year period. These costs, as presented in Table 1, include several items which are not ordinarily included in overhead. Consequently the total is larger than might be expected by most operators of sugar cane farms. The accounts kept by different operations vary somewhat. In combining the figures for different farms it was necessary to put such items as expenditures for oil, gas, grease, materials, and purchased feed in general overhead because in some of the records these items had not been classified as to the object—planting, cultivating, harvesting, etc. for which they had been used.

Since certain items which properly belong in other categories have been placed in general overhead, it is necessarily true that the expenses classified in other groups, particularly planting and cultivating, harvesting, and other crops, are somewhat lower than they should be. The item for oil, gas and grease should, no doubt, be divided among the three groups of costs mentioned, but it has not been possible to determine how much should be charged to each group.

The interest cost, shown in Table 1 represents a flat charge of 5 per cent on the book value of the farms, including buildings and equipment used in their operation. Interest cost per ton of cane was 36 per cent higher in 1940 than in 1939 and 25 per cent higher than in 1941. In contrast to this, interest costs per acre were 16 per cent lower in 1940 than in 1939 and 20 per cent lower than in 1941.

The total receipts from the operation of the farms were much lower in 1940 than in either of the other two years, because the tonnage of cane produced for sale was much lower. Receipts per ton were somewhat lower in 1940 than in 1939, but they were slightly higher than the receipts in 1941. Receipts per acre were highest in 1939 and lowest in 1940. They recovered considerably in 1941 but not enough to reach their 1939 level.

Both the net income and the net operating income of the farms were highest in 1939 and lowest in 1940. Unlike the costs and receipts this was true of the income per farm, per acre of cane grown and per ton of cane sold. While the costs per acre of cane grown were not high in 1940, the receipts were low. When calculated on a per ton basis receipts in 1940 were about normal, but costs were very high. As a result net incomes, both per acre and per ton, were low, or rather losses were high, in 1940. When considering the losses in net income incurred in 1940 and 1941 it is necessary to remember that these losses represent income after the deduc-

TABLE 1. COSTS AND RETURNS FROM THE OPERATION OF LARGE SUGAR CANE FARMS IN LOUISIANA, AVERAGE PER FARM, PER ACRE OF CANE GROWN AND PER TON OF CANE SOLD, 1939, 1940 AND 1941.

ITEMS OF COST AND RETURN	AVERAGE PER FARM			PER ACRE OF CANE GROWN			PER TON OF CANE SOLD		
	1939	1940	1941	1939	1940	1941	1939	1940	1941
General Overhead									
Labor	$ 8,043.19	$ 8,334.94	$ 8,344.21	$12.68	$13.00	$13.19	$ .60	$ .96	$ .73
Feed purchased	2,215.13	1,520.03	326.29	3.49	2.37	.52	.16	.18	.03
Materials	453.36	867.60	3,025.77	.71	1.35	4.78	.03	.10	.26
Oil, gas, grease	1,658.67	1,540.53	1,361.26	2.61	2.41	2.15	.12	.18	.12
Taxes	1,843.42	1,861.37	1,458.60	2.91	2.90	2.31	.14	.21	.13
Insurance	863.17	611.60	719.50	1.36	.95	1.14	.06	.07	.06
Depreciation	3,825.02	3,462.16	3,319.59	6.03	5.40	5.25	.28	.40	.29
Other	2,864.90	3,293.16	3,945.22	4.52	5.14	6.24	.21	.38	.34
TOTAL	21,766.84	21,491.39	22,500.44	34.31	33.52	35.58	1.61	2.48	1.96
Planting and Cultivating									
Labor	8,273.61	9,042.39	7,015.83	13.04	14.10	12.52	.61	1.04	.61
Seed cane	3,186.33	2,247.04	3,172.76	5.02	3.50	5.66	.24	.26	.28
Fertilizer	1,790.86	1,949.23	1,741.24	2.82	3.04	3.11	.13	.23	.15
Other	136.67	30.24	857.43	.22	.05	1.53	.01	0	.07
TOTAL	13,387.47	13,268.90	12,787.26	21.10	20.69	22.81	.99	1.53	1.11
Harvesting cane									
Labor	11,699.12	6,604.64	8,092.49	18.44	10.30	12.79	.87	.76	.71
Other	397.68	319.87	599.72	.63	.50	.95	.03	.04	.05
TOTAL	12,096.80	6,924.51	8,692.21	19.07	10.80	13.74	.90	.80	.76
Other Crops									
Labor	2,043.60	1,946.10	1,254.58	3.22	3.04	1.98	.15	.23	.11
Seed	440.84	341.58	366.53	.70	.53	.58	.03	.04	.03
Fertilizer	362.90	262.61	205.84	.57	.42	.33	.03	.03	.02
Other	198.47	43.90	356.04	.31	.07	.56	.02	0	.03
TOTAL	3,045.81	2,594.19	2,182.99	4.80	4.06	3.45	.23	.30	.19
Interest	6,308.89	5,349.34	6,620.10	9.96	8.34	10.46	.47	.62	.57
TOTAL COST	56,605.81	49,628.33	52,783.00	89.24	77.41	86.04	4.20	5.73	4.59
Miscellaneous Credits	6,779.08	4,526.41	5,629.61	10.68	7.06	11.36	.50	.52	.49
Net Cost	49,826.73	45,101.92	47,153.39	78.56	70.35	74.68	3.70	5.21	4.10
Source of Receipts									
Cane sold	40,306.25	23,098.30	34,216.05	63.54	36.03	54.09	2.99	2.67	2.98
AAA payments	12,938.59	9,161.72	8,555.50	20.40	14.29	13.52	.96	1.06	.74
TOTAL	53,244.84	32,260.02	42,771.55	83.94	50.32	67.61	3.95	3.73	3.72

TABLE 1. COSTS AND RETURNS FROM THE OPERATION OF LARGE SUGAR CANE FARMS IN LOUISIANA, AVERAGE PER FARM, PER ACRE OF CANE GROWN AND PER TON OF CANE SOLD, 1939, 1940 AND 1941.—(Continued)

ITEMS OF COST AND RETURN	AVERAGE PER FARM			PER ACRE OF CANE GROWN			PER TON OF CANE SOLD		
	1939	1940	1941	1939	1940	1941	1939	1940	1941
Miscellaneous Receipts									
Cane for seed	$ 3,358.02	$ 2,646.69	$ 3,082.83	$ 5.29	$ 4.13	$ 6.22	$ .25	$ .31	$ .27
Other crops sold	1,595.39	1,256.89	1,592.14	2.52	1.96	3.21	.12	.14	.14
Livestock products sold	66.09	205.34	9.30	.10	.32	.02	*	.02	*
Other	1,759.46	417.49	945.34	2.77	.65	1.91	.13	.05	.08
TOTAL MISC.	6,779.08	4,526.41	5,629.61	10.68	7.06	11.36	.50	.52	.49
TOTAL RECEIPTS	60,023.92	36,786.43	48,401.16	94.62	57.38	78.97	4.45	4.25	4.21
Operating expenses	50,296.92	44,278.99	46,162.90	79.28	69.07	75.58	3.73	5.11	4.02
Net operating income	9,727.00	−7,492.56	2,238.26	15.34	−11.69	3.39	.72	− .86	.19
Net income	3,418.11	−12,841.90	−4,381.84	5.38	−20.03	−7.07	.25	−1.48	− .38
Capital investment	126,177.33	106,997.04	132,402.04	198.91	166.91	209.29	9.35	12.36	11.52
Cane produced—tons	14,820	9,912	12,578	23.36	15.15	19.32	......	......	......
Cane sold—tons	13,488	8,656	11,489	21.26	13.50	18.16	......	......	......
Cane grown—acres	634	641	633	......	......	......	......	......	......

*Less than 0.5 cents.

tion of a 5 per cent interest charge on the investment. Some of the farm operators actually paid that much or more in interest; others paid less. Net operating income represents income before deduction of any interest charge. Therefore, net operating income is a measure of the amount of money available from the year's operation for the payment of interest and other capital charges.

Geographic Variations

There are sufficient variations in the soil, climate, and other factors affecting production in the sugar cane region of Louisiana to produce significant differences in the costs of producing cane in different parts of the region. In an effort to measure some of the variations in financial results obtained in different parts of the area, the territory was divided into two regions. One of these, called the Teche region, includes all of the farms situated west of the Atchafalaya River. Most of these farms are situated close to Bayou Teche. The other area, called the Mississippi region, includes all of the farms east of the Atchafalaya

River. Most of these farms are situated close to the Mississippi River or to Bayou Lafourche. Doubtless there are important differences within each of these regions, but the number of farms from which records were obtained is too small to warrant the division of the area into more than two parts.

Table 2 shows the average costs and returns per ton of cane sold for each region for the years 1939, 1940 and 1941. In 1939 and 1940 the total costs per ton were lower in the Teche region than they were in the Mississippi region. In 1941 the costs were practically the same. The principal difference occurred in overhead costs. These costs were lowest in the Teche region in each of the three years. Planting and cultivating costs were highest in the Teche region in 1941, but were almost the same in both regions in the other two years. Harvesting costs were lower in the Teche than in the Mississippi region each year, while interest costs were slightly higher in the Teche region except in 1940.

TABLE 2. GEOGRAPHIC VARIATIONS IN THE COSTS AND RETURNS OF OPERATING LARGE SUGAR CANE FARMS IN LOUISIANA, AVERAGE PER TON OF CANE SOLD, 1939, 1940 AND 1941.

ITEMS OF COST AND RETURN	AVERAGE PER TON OF CANE SOLD					
	1939		1940		1941	
	Miss. region	Teche region	Miss. region	Teche region	Miss. region	Teche region
General overhead	$1.66	$1.47	$2.57	$ 2.26	$2.03	$1.85
Planting and cultivating	.98	1.01	1.54	1.52	1.04	1.23
Harvesting	.91	.84	.85	.69	.78	.72
Other crops	.21	.26	.33	.24	.19	.19
Interest	.46	.47	.64	.58	.55	.61
TOTAL	4.22	4.05	5.93	5.29	4.59	4.60
Receipts from:						
Cane sales	2.96	2.97	2.72	2.55	2.78	3.29
AAA payments	.97	.91	1.08	1.03	.77	.70
Miscellaneous sources	.52	.46	.53	.50	.57	.36
TOTAL	4.45	4.34	4.33	4.08	4.12	4.35
Operating expenses	3.76	3.58	5.29	4.71	4.04	3.99
Net operating income	.69	.76	− .96	− .63	.08	.36
Net income	.23	.29	−1.60	−1.21	− .47	− .25

In each of the three years, both net operating income and net income were higher in the Teche than in the Mississippi region. The difference between the two regions was quite small in 1939. In 1940 the farms in both regions suffered severe losses, but the losses per ton of cane were considerably greater in the Mississippi region. By 1941, the financial condition had improved to the point where the farms in both regions had a small positive net operating income, but showed losses when interest was included as a cost.

Table 3 shows certain comparisons between the two regions, in size of farms, use made of land and yield of cane. In general the farms in the Teche region were slightly smaller than those in the Mississippi region. A farm, as the term is used in this study, consists of a division of land operated as a unit under separate supervision. In several cases a single owner owned several farms. The average yield per acre of cane was somewhat higher in the Teche region in 1939 and 1940 and slightly lower in 1941. The difference in the yield of cane may explain part of the difference in costs between the two regions. In 1939 and 1940 costs per ton were somewhat lower in the Teche region where yields were higher, while in 1941 the situation was reversed both for costs and yields.

TABLE 3. GEOGRAPHIC VARIATIONS IN OPERATING RESULTS ON LARGE SUGAR CANE FARMS IN LOUISIANA, 1939, 1940 AND 1941.

OPERATING ITEMS	AVERAGE PER FARM					
	1939		1940		1941	
	Miss. region	Teche region	Miss. region	Teche region	Miss. region	Teche region
Size of farms—acres	1,807	1,919	1,636	1,871	2,037	1,665
Cultivated area—acres	1,144	1,100	962	1,192	1,252	888
Cane grown	660	584	574	704	739	515
Cane produced—tons	15,147	14,154	8,663	11,430	14,756	10,159
Cane sold—tons	13,888	13,044	7,603	9,872	13,524	9,228
Yield of cane produced per acre— tons	23.0	24.2	15.1	16.2	20.0	19.7
Per cent of total area cultivated	63.3	57.3	58.8	63.7	61.5	53.3
Per cent of total area in cane	36.5	30.4	35.1	37.6	36.3	30.9
Per cent of cultivated area in cane	57.7	53.9	59.7	59.1	59.0	58.0

Something more than one-half of the area of the farms was in cultivated land, and approximately one-third of the total area was in cane. The differences between the two regions in these respects were not large although the proportions were usually somewhat higher in the Mississippi than in the Teche region. The percentage of cultivated land in cane was likewise slightly higher in the Mississippi region. In both regions this percentage was lowest in 1939. Throughout the entire area the customary practice is to harvest three crops of cane from the same field and then plant it to corn and soybeans for one year before returning it to cane. If this was done without exception, 75 per cent of the cultivated land would be in cane. The actual percentages are considerably lower than this.

Relation of Number of Acres in Cultivation Per Farm to Financial Returns

All of the farms from which records were obtained for this study were relatively large size. In every case they relied almost exclusively on hired labor. In spite of this there were wide variations in size between the farms. Perhaps the most common measure of the size of a farm is the number of acres of land which it contains. However, this is not a very good measure of size for the present study. The farms contained widely varying amounts of swamp and waste land. The presence or absence of this land had very little affect on the sugar cane enterprise, which is the principal source of income of the farm operators.

Another measure of size, which is of greater significance than total area, is the number of acres in cultivation. Table 4 shows the relationship between the number of acres in cultivation and some of the results obtained from the operation of the farms in 1939, 1940 and 1941. Each year the total cost of operating the farm, per ton of cane sold, was somewhat lower for the smallest than it was for the largest farms. However, the relationship between size and cost was not consistent for farms of intermediate size in any of the three years. Since the number of farms,

TABLE 4. RELATION BETWEEN THE NUMBER OF ACRES IN CULTIVATION PER FARM AND THE RESULTS OF OPERATION FOR LOUISIANA FARMS, 1939, 1940 AND 1941.

ACRES IN CULTIVATION	Number	PER TON OF CANE SOLD				Tons of cane sold	Yield per acre in tons*	Percent of cultivated area in cane
		Total cost	Total receipts	Net operating income	Net income			
1939—Under 500	18	$ 4.19	$ 4.36	$ .65	$ .17	4,774	23.2	54.6
500 to 999	42	4.09	4.36	.70	.27	9,474	23.2	60.1
1,000 to 1,999	19	4.08	4.13	.56	.05	16,681	24.4	51.7
2,000 and over	9	4.31	4.72	.86	.41	43,878	22.8	56.5
ALL FARMS	88	4.20	4.45	.72	.25	13,488	23.4	56.2
1940—Under 500	18	5.86	4.25	− .99	−1.61	3,091	15.6	60.3
500 to 999	42	5.09	3.88	− .68	−1.21	6,610	16.2	62.6
1,000 to 1,999	23	5.49	4.09	− .80	−1.40	10,651	16.6	56.4
2,000 and over	7	6.86	4.95	−1.14	−1.91	28,679	13.4	59.2
ALL FARMS	90	5.73	4.25	− .86	−1.48	8,656	15.5	59.4
1941—Under 500	18	4.21	5.16	1.32	.95	6,057	23.6	71.7
500 to 999	21	4.85	4.54	.42	− .31	8,208	18.9	61.1
1,000 to 1,999	31	4.61	4.09	.05	− .52	14,635	19.5	61.2
2,000 and over	6	4.53	3.45	1.66	1.08	23,011	20.2	57.5
ALL FARMS	76	4.59	4.21	.19	− .38	11,489	19.9	61.6

*The yield is based on the total number of tons produced, rather than the number sold.

particularly in the largest sized group, was small in each of the three years it is doubtful if much significance can be attached to the variations in cost shown in the table.

The relationship between net income and the number of acres in cultivation is even less consistent than was the case with costs. Apparently the financial success of the large sugar cane farms was not affected in any appreciable degree by the size of the area under cultivation.

It is also apparent from Table 4 that there was no consistent relationship between the size of the area cultivated and either the yield of cane per acre or the per cent of cultivated land devoted to the cane crop. The number of tons of cane sold, of course, increased with the number of acres cultivated, because of the accompanying increase in the number of acres planted to sugar cane.

TABLE 5. RELATION BETWEEN THE NUMBER OF ACRES IN CANE PER FARM AND THE RESULTS OF OPERATION OF LOUISIANA FARMS, 1939, 1940 AND 1941.

ACRES IN CANE	Number of farms	PER TON OF CANE SOLD				Tons of cane sold	Yield per acre in tons*	Per cent of cultivated area in cane
		Total cost	Total receipts	Net operating income	Net income			
1939—Under 250	15	$ 4.40	$ 4.30	$ .44	$−.10	4,360	23.8	47.6
250 to 499	33	4.04	4.45	.83	.41	8,272	22.6	57.4
500 to 749	23	4.08	4.24	.58	.16	12,429	23.2	57.4
750 to 999	6	4.38	3.96	1.13	.42	18,752	24.2	55.9
1,000 and over	11	5.25	4.64	.84	.39	40,386	22.9	56.7
ALL FARMS	88	4.20	4.45	.72	.25	13,488	23.4	56.2
1940—Under 250	13	6.29	4.43	−1.13	−1.86	2,493	15.6	50.7
250 to 499	35	5.08	3.91	− .65	−1.17	5,770	16.5	58.6
500 to 749	26	5.39	4.05	− .81	−1.34	8,814	16.4	61.5
750 to 999	6	5.47	4.13	− .82	−1.34	10,495	14.9	61.3
1,000 and over	10	6.51	4.70	−1.06	−1.81	25,249	14.1	59.2
ALL FARMS	90	5.73	4.25	− .86	−1.48	8,656	15.5	59.4
1941—Under 250	10	5.75	4.88	− .16	− .87	3,481	20.8	56.3
250 to 499	24	4.22	4.68	.99	.46	8,287	21.6	60.9
500 to 749	16	4.87	4.69	.53	− .18	10,658	19.0	61.7
750 to 999	16	4.67	3.88	− .23	− .79	15,663	19.0	63.0
1,000 and over	10	4.45	4.07	.13	− .38	21,833	20.1	61.4
ALL FARMS	76	4.57	4.21	.19	− .38	11,489	19.9	61.6

*The yield is based on the total of tons produced, rather than the number sold.

Relation of the Number of Acres in Cane Per Farm to Financial Returns

Another measure of the size of sugar cane farms is the number of acres planted to cane. This, of course, is one measure of the size of the principal enterprise on sugar cane farms. The relationship between the number of acres in cane and some of the results obtained from the operation of the farms is shown in Table 5. In general the total costs of operating the farms, per ton of cane sold, were relatively high for the farms with the smallest and the largest acreage in cane. Costs were lower for farms between the two extremes in size. Each year the farms with the lowest costs were those in the second group, which had between 250 and 499 acres in cane. From this point there was a gradual increase in unit costs as the number of acres in cane increased. These relationships were less consistent in 1941 than they were in the other two years.

There was very little consistent relationship between total receipts per ton of cane and the number of acres in cane per farm. Consequently both net operating income and net income showed some tendency to be relatively low for the farms with the smallest and largest number of acres in cane. Farms of intermediate size had somewhat better incomes. The relationship was less consistent than it was in the case of costs, primarily because of the random variation in total receipts.

Yields per acre of cane appear to have been entirely unrelated to the size of the cane acreage. Also differences in yields between the various groups of farms were too small to be of much significance.

However, the farms with the lowest acreage of cane had the smallest percentage of their cultivated area devoted to cane. This was true in each of the three years. In none of the years did the farms with the largest acreage in cane have the highest percentage of their cultivated land in cane. The farms which concentrated on cane to the greatest extent were always in the intermediate size groups. Each year, during the three year period, there was an increase in the per cent of cultivated land used for the cane crop. This increase occurred, without exception, for each group of farms, as well as for the annual averages of all groups. Apparently the tendency towards greater specialization on the cane enterprise during this period was common to all farms regardless of variations in size.

Relation of Number of Tons of Cane Sold Per Farm to Costs and Returns

A final measure of size of sugar cane farms in Louisiana which will be considered is the number of tons of cane sold per farm. Table 6 shows the relationship between the tonnage of cane sold and the costs of operating the farms. Each year total costs per ton declined as the number of tons sold increased. The only exception to this was the group of farms with the largest tonnage, that is, those with 20,000 or more tons in 1939 and 1941 and 10,000 or more in 1940. The reduction in cost with increased tonnage was the most marked in 1940, which was a poor crop year, and the least in 1939 when crop yields were highest.

TABLE 6. RELATION BETWEEN THE NUMBER OF TONS OF CANE SOLD PER FARM AND THE COST OF PRODUCING CANE PER TON SOLD, ON LOUISIANA FARMS, 1939, 1940 AND 1941.

TONS OF CANE SOLD	Number of farms	COST PER TON OF CANE SOLD					
		Total	General overhead	Planting and cultivating	Harvesting	Other crops	Interest
1939—Under 5,000	13	$ 4.49	$ 1.77	$ 1.04	$ .94	$ .14	$ .60
5,000 to 9,999	30	4.13	1.66	.92	.92	.22	.41
10,000 to 14,999	25	4.00	1.64	.85	.89	.18	.44
15,000 to 19,999	9	3.98	1.39	.86	1.04	.24	.45
20,000 and over	11	4.32	1.60	1.15	.81	.26	.50
ALL FARMS	88	4.20	1.61	.99	.90	.23	.47
1940—Under 2,500	10	7.72	3.17	2.23	.92	.50	.90
2,500 to 4,999	18	6.14	2.61	1.56	.87	.40	.70
5,000 to 7, 499	26	5.49	2.41	1.39	.82	.36	.51
7,500 to 9,999	19	5.49	2.40	1.39	.87	.26	.57
10,000 and over	17	5.76	2.48	1.62	.74	.26	.66
ALL FARMS	90	5.73	2.48	1.53	.80	.30	.62
1941—Under 5,000	10	6.08	2.78	1.12	1.11	.28	.79
5,000 to 9,999	24	4.85	1.90	1.13	.80	.23	.79
10,000 to 14,999	20	4.53	2.10	1.12	.70	.11	.50
15,000 to 19,999	15	4.38	1.77	1.15	.72	.25	.49
20,000 and over	7	4.42	1.93	1.03	.77	.15	.54
ALL FARMS	76	4.59	1.96	1.11	.76	.19	.57

The most important reductions in cost associated with larger tonnages were those in the group of overhead costs. Nearly one-half of the total reductions for the three years occurred in this group. Also the relationship between overhead costs and the average tonnage of cane per farm was quite consistent in each of the three years.

Planting and cultivating costs declined fairly consistently with increased tonnages in 1939 and 1940, but the relationship did not hold very well in 1941. Variations in harvesting costs and in the costs for other crops appeared to have little or no relationship to the tonnage of cane sold. Interest costs, on the other hand, declined rather consistently with increases in the tonnage of cane sold, except for the group of farms with the largest tonnage for which there was some increase in interest cost.

The relation between the tonnage of cane sold and the income received by the farms was not so close as it was in the case of costs (Table 7). As might be expected, total receipts per ton of cane sold were unaffected by the volume of sales. Net operating income was generally larger, or losses lower, as the tonnage of cane sold by the farms increased. However, the relationship was not entirely consistent, especially in 1941.

The behavior of net income was similar to that of net operating income except that the differences among the various groups of farms were somewhat larger. For instance the average difference in net operating income for the three years, between the farms with the smallest and largest tonnages was 55 cents per ton as compared with 75 cents for net income. The difference is the result of lower interest costs per ton on the farms with the large tonnages.

TABLE 7. Relation Between the Number of Tons of Cane Sold Per Farm and the Income Per Ton of Cane Sold on Louisiana Farms, 1939, 1940 and 1941.

Tons of cane sold	Number of farms	Income per ton of cane sold					
		Total receipts	Cane sales	Government payments	Other receipts	Net operating income	Income Net
1939—Under 5,000	13	$ 4.40	$ 2.99	$ .98	$ .43	$ .51	$−.09
5,000 to 9,999	30	4.42	3.07	.95	.40	.70	.29
10,000 to 14,999	25	4.33	2.94	.91	.48	.77	.33
15,000 to 19,999	9	4.02	2.77	.93	.32	.49	.04
20,000 and over	11	4.61	3.00	.98	.63	.79	.29
All farms	88	4.45	2.99	.96	.50	.72	.25
1940—Under 2,500	10	4.91	2.78	1.33	.80	−1.91	−2.81
2,500 to 4,999	18	4.22	2.67	1.07	.48	−1.22	−1.92
5,000 to 7,499	26	4.15	2.65	1.07	.43	− .83	−1.34
7,500 to 9,999	19	4.23	2.64	1.05	.54	− .69	−1.26
10,000 and over	17	4.27	2.68	1.04	.55	− .83	−1.49
All farms	90	4.25	2.67	1.06	.52	− .86	−1.48
1941—Under 5,000	10	4.80	3.80	.69	.31	− .49	−1.28
5,000 to 9,999	24	4.63	3.36	.88	.38	.57	− .22
10,000 to 14,999	20	4.77	3.46	.77	.54	.74	.24
15,000 to 19,999	15	3.75	2.62	.63	.50	− .14	− .63
20,000 and over	7	3.69	2.40	.74	.55	− .19	− .73
All farms	76	4.21	2.98	.74	.49	.19	− .38

Table 8 shows the relationship between the tonnage of cane sold and certain physical facts related to the operation of the sugar cane farms. Perhaps the most interesting fact shown is the tendency of the yield of cane per acre to be somewhat higher on the large farms than it was on those with the smaller tonnages of cane for sale. The differences between the various groups of farms in any one year were not large, but they were reasonably consistent each year in their relationship to the tonnage of cane sold. This makes it appear that the larger farms were operated somewhat more effectively than the smaller ones or that they contained better land for the production of cane.

TABLE 8. Relation Between the Number of Tons of Cane Sold Per Farm and Various Physical Factors Related to Production Costs on Louisiana Farms, 1939, 1940 and 1941.

Tons of cane sold	Number of farms	Size of farms			Cane produced	Yield of cane per acre	Per cent of total area cultivated	Per cent of total area in cane	Percent of cultivated area in cane
		Total	In cultivation	In cane					
		Acres	*Acres*	*Acres*	*Tons*	*Tons*			
1939—Under 5,000	13	740	425	201	4,243	21.1	57.3	27.2	47.4
5,000 to 9.999	30	931	649	375	8,490	22.6	69.7	40.3	57.8
10,000 to 14,999	25	1,574	967	545	12,977	23.8	61.4	34.6	56.4
15,000 to 19,999	9	2,191	1,403	783	18,925	24.2	64.0	35.7	55.8
20,000 and over	11	5,727	3,412	1,935	45.416	23.5	59.6	33.8	56.7
All farms	88	1,845	1,129	634	14,820	23.4	61.2	34.4	56.2
1940—Under 2,500	10	690	374	191	2,376	12.4	54.2	27.7	51.1
2,500 to 4,999	18	922	554	331	4,419	13.4	60.1	35.9	59.7
5,000 to 7,499	26	1,346	791	463	6,969	15.1	58.8	34.4	58.5
7,500 to 9,999	19	1,901	1,025	645	9,789	15.2	53.9	33.9	62.9
10,000 and over	17	3,921	2,551	1,502	23,739	15.8	65.1	38.3	58.9
All farms	90	1,792	1,079	641	9,912	15.5	60.2	35.8	59.4
1941—Under 5,000	10	597	322	188	3,636	19.3	53.9	31.5	58.4
5,000 to 9,999	24	1,314	807	463	8,662	18.7	61.4	35.2	57.4
10,000 to 14,999	20	1,879	930	632	13,026	20.6	49.5	33.6	68.0
15,000 to 19,999	15	2,755	1,463	915	18,300	20.0	53.1	33.2	62.5
20,000 and over	7	3,564	2,131	1,246	25,240	20.3	59.8	35.0	58.5
All farms	76	1,860	1,027	633	12,578	19.9	55.2	34.0	61.6

The percentage of cultivated land used for the cane crop was somewhat smaller each year for the smallest farms than it was for most of the larger groups. While the relationship among the various groups of farms was not entirely consistent, it was close enough to indicate that the smallest farms, at least, did not specialize quite so much on the sugar cane enterprise as did the larger farms. It was also true that the per cent of the total area in the farms which was used for cultivated crops was lower on the smallest sized group of farms than it was on the other groups. There were only two exceptions to this throughout the three-year period.

Relation of Yield of Cane per Acre to Financial Returns

Sugar cane growers in Louisiana have generally recognized that one of the most important factors influencing their profits is the yield per acre of cane which they obtain. Because of this fact consistent efforts have been made by the farm operators to obtain high yields. However, the yields actually obtained have varied widely, both from year to year

TABLE 9. RELATION BETWEEN THE YIELD OF CANE PER ACRE AND THE COST, PER TON OF CANE SOLD, OF OPERATING LARGE SUGAR CANE FARMS IN LOUISIANA, 1939, 1940 AND 1941.

YIELD PER ACRE—TONS	Number of farms	COST PER TON OF CANE SOLD					
		Total cost	General over-head	Planting and cultivating	Harvesting	Other crops	Interest
1939—Under 16	3	$ 5.16	$ 2.11	$ 1.20	$ 1.05	$ .11	$ .69
16 to 18.9	20	4.42	1.65	1.09	.92	.30	.46
19 to 21.9	23	4.30	1.66	1.02	.90	.26	.46
22 to 24.9	28	3.90	1.47	.96	.84	.20	.43
25 to 27.9	8	3.55	1.37	.88	.89	.06	.35
28 and over	6	4.41	1.90	.71	.91	.16	.73
ALL FARMS	88	4.20	1.61	.99	.90	.23	.47
1940—Under 10	3	9.30	3.94	2.22	.93	.76	1.45
10 to 12.9	17	6.50	2.84	1.70	.90	.35	.71
13 to 15.9	39	5.87	2.51	1.65	.79	.31	.61
16 to 18.9	21	5.30	2.40	1.36	.72	.27	.55
19 to 21.9	8	5.13	2.22	1.17	.91	.27	.56
22 and over	2	4.29	1.30	1.14	.98	.08	.79
ALL FARMS	90	5.73	2.48	1.53	.80	.30	.62
1941—Under 16	7	5.87	2.55	1.36	.86	.29	.81
16 to 18.9	17	5.35	2.23	1.15	.80	.41	.76
19 to 21.9	36	4.38	1.87	1.09	.75	.15	.52
22 to 24.9	8	4.53	1.88	1.12	.69	.15	.69
25 and over	8	3.39	1.53	.98	.68	.01	.19
ALL FARMS	76	4.59	1.96	1.11	.76	.19	.57

and between different farms in the same year. The yearly variations in yield appear to be largely the result of variations in weather. The variations among different farms in the same year are partly the result of variations in weather and soils in different parts of the cane growing area, but it is probable that a considerable part is the result of variations in farming among different farm operators.

Table 9 shows that there was a consistent tendency for the cost per ton of cane sold to decline as the yield per acre of cane increased. In 1939 the difference in cost between the group of farms with the lowest and that with the highest yield amounted to 75 cents per ton or 14.5 per cent of the cost of the low yield group. In 1940 the difference was $5.01 and 53.9 per cent and in 1941, $2.48 and 42.2 per cent. The difference in 1939 would have been much greater if the comparison had been made with the group of farms obtaining yields between 25 and 27.9 tons rather than with the group obtaining 28 or more tons. In any event the differences each year were large enough to be highly significant to the operators of sugar cane farms.

TABLE 10. RELATION BETWEEN THE YIELD OF CANE PER ACRE AND THE INCOME, PER TON OF CANE SOLD, FROM THE OPERATION OF LARGE SUGAR CANE FARMS IN LOUISIANA, 1939, 1940 AND 1941.

YIELD PER ACRE—TONS	Number of farms	INCOME PER TON TO CANE SOLD					
		Total receipts	Cane sales	Government payments	Other receipts	Net operating income	Net income
1939—Under 16	3	$ 4.52	$ 3.00	$ .95	$ .57	$ .05	$− .64
16 to 18.9	20	4.59	3.04	1.01	.54	.63	.17
19 to 21.9	23	4.61	3.04	1.00	.57	.77	.31
22 to 24.9	28	4.28	2.92	.90	.46	.81	.38
25 to 27.9	8	4.04	2.79	.89	.36	.84	.49
28 and over	6	4.10	2.84	.88	.38	.42	− .31
ALL FARMS	88	4.45	2.99	.96	.50	.72	.25
1940—Under 10	3	4.37	2.52	1.15	.70	−3.48	−4.93
10 to 12.9	17	4.32	2.64	1.06	.62	−1.47	−2.18
13 to 15.9	39	4.26	2.68	1.09	.49	−1.00	−1.61
16 to 18.9	21	4.24	2.67	.98	.59	− .51	−1.06
19 to 21.9	8	4.17	2.68	1.16	.33	− .40	− .96
22 and over	2	4.72	2.48	.92	.32	1.22	.43
ALL FARMS	90	4.25	2.67	1.06	.52	− .86	−1.48
1941—Under 16	7	4.83	3.40	.84	.59	.37	− .44
16 to 18.9	17	3.86	2.49	.71	.66	− .73	−1.49
19 to 21.9	36	4.08	2.99	.68	.41	.22	− .30
22 to 24.9	8	4.98	3.72	.84	.42	.84	.15
25 and over	8	5.07	3.63	.90	.54	1.87	1.68
ALL FARMS	76	4.21	2.98	.74	.49	.19	− .38

In general each of the five groups of costs tended to decline as the yields per acre increased, although the relationship was not entirely consistent in certain cases. The most important reduction in costs occurred in the group of overhead costs. This accounted for almost one-half the reduction in total costs. There was also a consistent decline in planting and cultivating costs and in interest costs. Harvesting costs declined very little with increases in yield. This was to be expected since much of the labor used in harvesting was paid on a piece-work or per ton basis and such expenses are unaffected by yields.

The relation of income per ton of cane to the yield is shown in Table 10. While there was considerable variation among the different groups of farms in their total receipts per ton of cane sold, these appeared to be random in character and unrelated to the yield of cane. On the other hand there was a distinct tendency for both net operating income and net income to increase as the yield of cane increased. The increase in net operating income, from the group of farms with the lowest yield to the group with the highest yield averaged $2.19 for the three year period. The increase in net income averaged $2.60. The difference between the two figures is caused by the decline in interest costs that occurred with increasing yields.

The data in Table 11 indicate that there was very little consistent relationship between yields and the size of farms. This was substantially true no matter what measure of size was used. In 1939 and 1940 the number of acres in cane was relatively small on the farms with the lowest yields, but in 1941 the number was considerably larger than average. The farms with the largest number of acres in cane had about average yields in the first two years of the period studied, but again this was not quite true in 1941. However, it was true in each of the three years that the farms with the highest yields had a smaller than average acreage planted to cane. Except in 1939 the number of tons of cane produced and the number sold was lower on the farms with the highest yields than it was for the average of the entire group of farms.

The distribution of land use, as shown by the per cent of the area in the farms which was cultivated, the per cent which was in cane, or the per cent of cultivated land in cane, did not vary in any consistent manner with the variations in the yield of cane. The per cent of cultivated land in cane was considerably lower for the farms with the lowest yields than it was for the farms with the highest yields in 1940 and 1941. However, in 1939 there was very little difference. The per cent of the total area of the farms which was used for the cane crop varied widely between different groups of farms. It was low on the farms with the lowest yields in 1939 and 1940, but was unusually high on the same group of farms in 1941. There was no tendency for the proportion of the total farm land which was devoted to cane to increase over the three year period as was true of the proportion of cultivated land in cane.

TABLE 11. RELATION BETWEEN THE YIELD OF CANE PER ACRE AND VARIOUS PHYSICAL FACTORS RELATED TO PRODUCTION COSTS ON LOUISIANA FARMS, 1939, 1940 AND 1941.

YIELD PER ACRE—TONS	Number of farms	SIZE OF FARMS			Cane produced	Cane sold	Per cent of total area cultivated	Per cent of total area in cane	Percent of cultivated area in cane
		Total	In cultivation	In cane					
		Acres	*Acres*	*Acres*	*Tons*	*Tons*			
1939—Under 16	3	1,617	687	349	6,052	5,273	42.5	21.6	50.8
16 to 18.9	20	2,105	1,292	733	14,901	13,386	61.4	34.8	56.7
19 to 21.9	23	2,315	1,359	768	17,203	15,650	58.7	33.2	56.6
22 to 24.9	28	1,500	957	545	13,715	12,763	63.8	36.3	56.9
25 to 27.9	8	1,156	820	478	13,255	12,493	71.0	41.4	58.3
28 and over	6	1,812	1,119	560	17,042	15,809	61.8	30.9	50.1
ALL FARMS	88	1,845	1,129	634	14,820	13,488	61.2	34.4	56.2
1940—Under 10	3	2,299	744	389	3,248	2,682	32.4	16.9	52.3
10 to 12.9	17	1,465	891	561	6,748	5,824	60.8	38.3	63.0
13 to 15.9	39	1,880	1,192	730	10,712	9,533	63.4	38.8	61.2
16 to 18.9	21	1,922	1,193	675	11,470	10,370	62.1	31.1	56.6
19 to 21.9	8	1,752	905	453	9,188	8,426	51.7	25.8	50.0
22 and over	2	886	482	359	8,729	7,451	54.4	40.5	74.5
ALL FARMS	90	1,792	1,079	641	9,912	8,656	60.2	35.8	59.4
1941—Under 16	7	1,460	1,111	762	11,795	10,612	76.1	52.2	68.6
16 to 18.9	17	1,333	856	531	9,456	8,540	64.2	39.8	62.0
19 to 21.9	36	2,332	1,203	726	14,709	13,513	51.6	31.1	60.3
22 to 24.9	8	1,476	1,082	513	12,480	11,430	73.3	34.8	47.4
25 and over	8	1,594	480	397	10,407	9,472	30.1	24.9	82.7
ALL FARMS	76	1,860	1,027	633	12,578	11,489	55.2	34.0	61.6

SUMMARY

The financial returns obtained by the operators of large sugar cane farms in Louisiana were modest, even in 1939 which was by far the best of the three years analyzed in this study. In 1940 nearly every one of the farms for which data were obtained suffered serious financial losses. This was primarily the result of very low yields of cane, which in turn were the result of unfavorable weather. In 1941 financial returns were much better than in 1940, but the average net operating income of $2,238.26 per farm was equal to only 1.7 per cent of the investment in the farms. Interest on borrowed funds amounted to more than this for many of the operators of the farms.

Various factors have been shown to be related, more or less closely, to the cost and income of operating the farms. For instance, the total cost per ton of cane sold was higher in the Mississippi than in the Teche region in both 1939 and 1940, and was almost the same in 1941. In each of the three years the net income per ton of cane of the farms in the Teche was higher, or losses lower, than in the Mississippi region. Among the reasons for this is the fact that yields of cane per acre averaged higher in the Teche than in the Mississippi region in 1939 and 1940, but were practically the same in 1941.

The yield of cane per acre probably had a greater influence on costs and returns per ton of cane, than did any other factor whose influence could be measured. This is shown both by the fact that costs varied directly with variations in average yields from year to year and that each year farms with high yields had lower unit costs than did farms with lower yields. Moreover the differences, both in cost and income were large enough to be of great financial importance to the owners and operators of the farms.

The relationship between size of farm and financial returns was not entirely consistent. This was largely true no matter what measure of size was used. One important fact that needs to be remembered in this connection is that a farm frequently does not represent all of the land under the control of a single owner. Rather, a farm consists of all the land which was operated essentially as a single unit under any type of management. The owners of large acreages of land have divided their holdings into farm units which, in their opinion, give them the most efficient operation. The results of this study do not show that there was any clear advantage of one size of unit over other sizes. It seems probable that the individual pecularities of each farm, or group of farms under a single ownership, have been the most important controlling factor in determining the size of each farm.

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DEPTH AND METHODS OF PLANTING WINTER COVER-CROP SEED IN LOUISIANA

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DEPTH AND METHODS OF PLANTING WINTER COVER-CROP SEED IN LOUISIANA

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INTRODUCTION

It has been well demonstrated that winter cover-crops are very helpful in maintaining the fertility of field soils. They are helpful in that they tend to prevent erosion, add needed organic matter to the soil, and, in case of well-inoculated, legume cover-crops, add much nitrogen.

Unfortunately cover-crops planted in Louisiana are often failures. This is due to several causes. Often too little care is taken in planting. The soil may be left too cloddy and rough, it may be so littered with grass and weeds that the young plants cannot get a good foot-hold in the soil, or, if they do get a start, the drainage may be so poor that they perish later. Frequently the crop is not properly seeded. There may not be enough seed used, or they may not be well covered, or they may be covered too deep. Also the soil may be too dry, especially for successful inoculation, or too poor, being deficient in phosphorous and lime.

This bulletin will not attempt to solve all the problems mentioned above, but it will present some data, gathered from experimental work, that have a bearing on some of the problems. Additional suggestions based on the work and observations of others will be offered.

REVIEW OF LITERATURE

A brief survey of the literature on the subject indicates that but very little definite experimental work has been done on the subjects considered in this bulletin. Moore (1)[2] of North Carolina did some work on the depth of planting seed of certain small seeded legumes and grasses. For the smallest seeds, like those of clovers, alfalfa, timothy, and orchard grass, optimum emergence was obtained from a depth of ¼ to ½ inch. About one-half as many seed germinated from surface planting as from the optimum depth, and a similar number from the 1 inch depth. The seedlings that did emerge from the deeper plantings were slower in appearing and much weaker. Moore also planted seed of four varieties of Lespedeza. On the average with this crop, optimum germination was obtained from surface planting, but this was but very little better than was obtained from a depth of ¼ to ½ inch. With Kobe and Korean Lespedeza, good emergence was had from 1 inch depth and fair from 1½ inches but very few plants from a depth of 2 inches. Tenn. No. 76 and Sericea gave only fair emergence at a depth of 1 inch and practically none at a depth of 1½ inches and deeper. Sudan grass seed, which are larger than the other seeds mentioned above, gave best emergence at a depth of 1 to 2 inches but as the depth increased beyond this there was a gradual reduction in number of plants, although, at 5 inches the emergence was 56 per cent.

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[1] Dr. Franklin L. Davis and Claud A. Brewer, Jr., planted the seed and made the plant counts in the depth of planting experiment at Baton Rouge, in 1941.

[2] The figures in parentheses refer to literature cited on the last page of this bulletin.

Kinney, Kenny, and Fergus (2) of Kentucky, and Murphy and Arny (3) of Minnesota reported that grass and legume seeds, unless planted very shallow, produced a low percentage of seedlings.

Wasson (4) of Louisiana recommended that bur clover seed be covered very lightly, if at all, but that the seed of other crops such as Austrian winter peas and the vetches be covered 1½ to 3 inches. He further mentioned as the three most essential things in planting a cover-crop: thorough inoculation; thoroughly covering the seed to the proper depth; and proper drainage.

Davis, Hobgood, and Brewer (5), after experimenting with the culture of Austrian winter peas and vetch as winter cover-crops in a number of different locations in Louisiana for a three-year period, made the following recommendations:

"1. Plant between September 15 and October 15 when the soil is moist.

"2. Use plenty of seed to insure a good stand. Twenty pounds of hairy vetch or 30 pounds of Austrian winter peas are enough if the seed are drilled. More are needed if broadcast.

"3. Inoculate the seed. Inoculation of the seed each year can be considered as an insurance against a crop failure until it is known that effective nodule-forming organisms are established in the soil.

"4. Plant the seed from 2 to 3 inches deep in heavy soils and from 2 to 4 inches deep in light sandy soils.

"5. Use from 200 to 250 pounds of superphosphate or from 400 to 500 pounds of basic slag per acre on winter legumes planted on cotton land unless it is known that the soil is well supplied with phosphorus.

"6. Leave the soil well bedded, with the seed in the ridges. Winter legumes will "drown out" on poorly drained soils during the rainy season that usually occurs in late winter or early spring."

Davis and Brewer (6) found that liming soils low in calcium content enabled the crops to utilize larger quantities of the phosphorus supplied in applications of superphosphate. Lime alone produced an increase in percentage content of calcium only, while lime applied with superphosphate resulted in an increased content of calcium, phosphorus, and nitrogen in the plants.

A letter of inquiry in regard to cover-crop culture work was recently addressed to various agronomists at agricultural experiment stations and other institutions in the South. The replies indicated that but very little experimental work has been done in this area on depth and methods of planting winter cover crop seed. Some observations offered indicated that it is the general consensus of opinion that cover-crop seed should not be planted deeper than two inches and that small seeds such as those of the clovers should be barely covered.

DEPTH OF PLANTING EXPERIMENTS

Depth of Planting Experiments at Baton Rouge:

The experiments at Baton Rouge were conducted on old Olivier silt loam, a Mississippi River terrace soil that was naturally poor, being especially low in nitrogen and phosphorous. It had a pH of about 5.4. No fertilizers were applied. Soil of this type runs together and compacts badly during hard rains.

In 1940 the seeding was done by hand on October 18. Furrows were made the required depths and checked with a rule. The recommended rate of seeding for each crop was used, the seed needed for a 6-foot row being weighed, counted, and inoculated with proper bacterial culture. The soil was well pulverized when planting was done and was relatively dry on the surface. Moisture percentages were as follows: surface, 0.9%; 2 inches, 14.2%; 4 inches, 15.4%; 6 inches, 15.4%; 8 inches, 19.3%. There was no rain until October 31, when a 1.2-inch rainfall occurred. A rain of 5.9 inches fell on November 9 and 10.

The laboratory germination of all seed used was very good as may be seen from table 1. The bur clover and Melilotus contained some hard seeds. In the case of bur clover, a whole bur was counted as a seed when planting was done, and with the oats, all the small seeds were counted although some were probably too small to contain a good kernel.

Preliminary germination counts were made on October 29. At that time none of the seed on the surface of the soil had germinated. (No rain had fallen since the seeding was done.) The Austrian winter peas had nearly all emerged from the various depths of coverage; a fourth to a third of the common and hairy vetch plants had emerged from the 2, 4, and 6 inch plantings, but none from the 8 inch. There were no bur clover or Melilotus plants showing in any of the plantings. There was a good stand of oats in the 4-inch bed, but none on the 2-inch and only a few on the 6- and 8-inch beds. The loose soil and lack of rain probably favored the emergence of plants from the deeper plantings. Had there been a hard rain soon after the seeding it is doubtful if the emergence would have been so good.

The plants in all the plots were dug up on December 14, counts were made, and roots examined for nodules. Table 1 gives in detail results of

TABLE 1. Field Germination and Inoculation of Plants in Cover Crop Depth of Planting Experiment Bench Land Soil, Baton Rouge—1940.

Crop	Depth of planting Inches	Seed planted in 6 ft. row	% germination in lab.	Series I		Series II		Series III		Series IV		Average % field germination	% inoculation
				No. Plants		No. Plants		No. Plants		No. Plants			
				In row	Inoc.	In row	Inoc.	In row	Inoc.	In row	Inoc.		
Austrian winter peas	0	90	98	40	1	36	0	36	2	48	0	44.4	1.9
	2			70	36	64	22	48	22	78	50	72.2	50.0
	4			68	28	36	20	36	16	38	14	49.4	43.8
	6			44	12	68	28	40	12	40	12	53.3	33.3
	8			48	2	46	8	36	10	24	2	42.8	14.3
Hairy vetch	0	257	91	103	11	90	0	96	20	124	14	40.1	10.9
	2			146	78	120	44	156	84	156	90	56.2	51.2
	4			156	44	170	122	122	38	64	16	49.7	42.9
	6			38	10	84	40	46	2	32	6	19.4	29.0
	8			10	0	54	10	16	0	2	0	7.9	12.0
Common vetch	0	173	99	82	3	64	6	98	2	84	2	47.4	3.9
	2			146	66	172	72	146	84	100	62	81.5	50.4
	4			116	10	144	70	110	8	56	14	61.5	23.9
	6			82	10	104	6	120	16	28	0	48.3	9.9
	8			36	0	142	4	94	0	20	0	42.2	1.4

TABLE 1—Continued

CROP	Depth of planting Inches	Seed planted in 6 ft. row	% germination in lab.	SERIES I		SERIES II		SERIES III		SERIES IV		Average % field germination	% inoculation
				No. Plants		No. Plants		No. Plants		No. Plants			
				In row	Inoc.	In row	Inoc.	In row	Inoc.	In row	Inoc.		
Bur clover	0	570 (burs)	75	255	51	396	66	180	28	188	60	44.7	20.1
	2			30	4	0	0	18	8	6	2	2.4	25.9
	4			0	0	0	0	0	0	0	0	0	0
	6			0	0	0	0	0	0	0	0	0	0
	8			0	0	0	0	0	0	0	0	0	0
Melilotus Indica	0	4731	92	820	0	1088	8	760	0	889	3	18.8	.3
	2			66	0	4	0	12	0	34	0	.6	0
	4			0	0	0	0	0	0	0	0	0	0
	6			0	0	0	0	0	0	0	0	0	0
	8			0	0	0	0	0	0	0	0	0	0
Oats	0	720	88	152		151		124		180		21.1	
	2			373		220		216		263		37.2	
	4			515		215		275		280		44.6	
	6			35		205		150		91		16.6	
	8			18		65		70		55		7.2	

the counts. It may be observed that there was a fair germination from the surface planting of all crops but that the inoculation of the surface seeded plants was low. In the case of the bur clover and Melilotus the surface planting was the only one that gave a stand. It is possible that a coverage of ¼ or ½ inch would have given a better stand than the surface planting but that depth was not tried. With the Austrian winter peas, hairy vetch, and common vetch, the 2-inch depth was the optimum. The 4-inch depth gave slightly better emergence of oats than the 2-inch, but this was doubtless due to the soil moisture conditions prevailing. The 2-inch depth gave better emergence other years. For successive depths greater than 4 inches there was, on the average, a gradual reduction in both emergence and percentage of inoculation.

The depth of planting cover-crop seed experiment at Baton Rouge in 1941 was planted on October 21 on the same land that was used in 1940 and planting methods were the same except that an additional depth, one inch, was used. At the time of planting the soil was loose and contained a fair amount of moisture. The moisture content, from laboratory determinations ran as follows: 0-1 inch deep, 3.1%; 2 inches, 11.7%; 4 inches, 13.8%; 6 inches, 14.0%; and 8 inches, 16.0%. A 1.27 inch rain fell on October 26-27. This rain moistened the soil without packing it and produced optimum conditions for the maximum emergence of plants. More rains fell as follows: October 30, 0.36 inch; October 31. 0.73 inch; November 4, 0.16 inch; November 11, 0.27 inch; and on November 21, 0.70 inch. An undetermined number of seeds of the surface plantings, particularly the oats, were eaten by birds which were seen on the plots after planting. Seed counts and laboratory germination for all crops were about the same as in 1940, except for Austrian winter peas which had a laboratory germination of but 70% in 1941.

The plants in one-half of each plot were dug up on December 11. They were carefully counted and their roots examined for nodules. The data obtained are given in table 2. Very poor stands were obtained from surface planting of all the crops except bur clover and Melilotus Indica. For the Melilotus, the surface planting was the only one that produced a stand, and for bur clover it was best, but there was a fair stand from the one-inch planting. For the other crops, as may be seen from table 2, the one-, two-, or four-inch depths were better. For depths greater than four inches, there was an appreciable reduction in both emergence and inoculation. The number of nodules per plant, as well as the percentage of plants having nodules, became smaller for the six- and eight-inch depths. The majority of the bur clover and Melilotus Indica plants was very small and nodules had not developed sufficiently to be accurately counted. Other crops of bur clover on nearby plots have always been well inoculated.

Conditions in 1941 differed from those prevailing in 1940 in that there was more moisture in the surface soil when planting was done and a moderate rain came not long after planting. Results, however, were

TABLE 2. DEPTH OF PLANTING WINTER COVER CROPS AT BATON ROUGE, 1941

CROP	Depth of planting Inches	SERIES I		SERIES II		SERIES III		SERIES IV		Average field germination %	Average field inoculation %
		No. Plants		No. Plants		No. Plants		No. Plants			
		3-ft. row	Inoc.	3-ft. row	Inoc.	3-ft. row	Inoc.	3-ft. row	Inoc.		
Austrian winter peas	0	4	2	9	0	4	1	5	2	11	23
	1	23	11	31	1	25	11	14	8	47	33
	2	17	9	25	2	20	13	22	20	42	52
	4	13	4	21	1	15	14	21	17	35	50
	6	11	1	9	1	11	7	15	6	23	33
	8	14	2	8	1	10	1	8	3	20	30
Hairy vetch	0	30	15	34	2	34	16	28	25	36	46
	1	62	9	68	5	56	40	88	88	78	52
	2	66	8	77	8	66	40	73	63	81	42
	4	64	1	62	20	61	45	57	51	70	48
	6	31	0	36	8	24	12	51	14	41	24
	8	39	1	31	1	26	11	34	5	37	14
Common vetch	0	17	0	20	1	8	4	15	1	23	10
	1	62	5	44	6	60	53	46	43	82	50
	2	45	6	55	9	62	42	64	63	87	53
	4	52	0	38	4	62	53	57	43	80	49
	6	40	0	41	1	45	36	48	9	67	27
	8	20	0	19	0	17	13	28	1	32	17

TABLE 2—Continued

CROP	Depth of planting Inches	SERIES I		SERIES II		SERIES III		SERIES IV		Average field germination %	Average field inoculation %
		No. Plants		No. Plants		No. Plants		No. Plants			
		3-ft. row	Inoc.	3-ft. row	Inoc.	3-ft. row	Inoc.	3-ft. row	Inoc.		
Bur clover	0	378	Nodules not formed	230		383	80	320	70	41	
	1	284		232		151	40	181	20	33	
	2	49		65		60	6	4	0	7	
	4	0		0		0		0		0	
	6	0		0		0		0		0	
	8	0		0		0		0		0	
Melilotus Indica	0	329	Nodules not formed	180		270		337		27	
	1	134		180		62		68		11	
	2	82		10		15		12		3	
	4	0		0		0		0		0	
	6	0		0		0		0		0	
	8	0		0		0		0		0	
Oats	0	13	..	10	..	2	..	3	..	2.5	..
	1	280	..	230	..	254	..	192	..	86	..
	2	270	..	210	..	242	..	220	..	85	..
	4	238	..	122	..	195	..	157	..	64	..
	6	21	..	24	..	2	..	11	..	5	..
	8	0	..	0	..	0	..	0	..	0	..

very similar. Both inoculation and emergence decreased with increase in depth greater than four inches.

The 1942 planting experiments at Baton Rouge were planted on October 24 on the same land used other years, and the same methods of planting were followed except that an additional crop, *Lathyrus pusillus* (Singletary peas), was included. Soil samples for moisture determination were taken from the different depths, but they were not used due to the fact that a gentle rain started falling the next day after planting and continued for a number of hours. Birds again ate some of the seed from the surface plantings.

The soil was moist and well pulverized when planting was done. The gentle rain and good growing conditions that followed favored a quick germination of seed. Emerged plants were counted on one series on November 5 which was 12 days after planting. No plants had yet appeared on the Lathyrus and Melilotus plots due largely to the fact that they were not planted until a week after the other plots were planted. At this date, November 5, due to the favorable weather conditions that had prevailed, the percentage of germination on most of the plots was high as may be seen from table 3. In fact, in some instances the table shows a higher percentage on this date than is shown for the total germination. This was due largely to the fact that but one series was counted at this date and four on December 14, the final date, when plants were dug up and counted. The counts for all four series were consistent and in line with results other years. To conserve space only the averages for 1942 are given in table 3, but three-year averages of plant emergence and inoculation are included.

During the three years that the experiments were in progress, there was some variation in moisture available, but, on the whole, conditions were rather favorable for germination and good stands were secured each year. As is shown in tables 1, 2, and 3 the figures obtained from different series and for different years for a certain crop are very consistent and are no doubt reliable. Except for bur clover and Melilotus, surface planting was not satisfactory. Of the depths of coverage tried, surface planting was the best for bur clover and Melilotus. A two-inch coverage was the optimum for most of the other crops grown but there was but little difference between one-inch and two-inch. A coverage greater than four inches resulted in lower germination and poorer inoculation regularly. Plants from the deeper plantings appeared to be weaker and, in some cases, although the seed germinated, the seedling plant was not strong enough to get above the surface of the soil.

Depth of Planting Experiments at Calhoun:

Depth of planting cover-crop seed experiments similar to those outlined above for Baton Rouge were conducted at the North Louisiana Experiment Station at Calhoun for a three-year period. Deep sandy loam soil was used. In 1940 only common vetch seed were planted. These were

TABLE 3. DEPTH OF PLANTING WINTER COVER CROP SEED AT BATON ROUGE, 1942

CROP	No. seed planted in 6-ft. row	Laboratory germ. %	Depth of planting Inches	FIELD GERMINATION			PERCENT PLANTS INOCULATED	
				% in 12 days*	Total % germ. 1942	3-yr. av. germ. %	In 1942	3-yr. av.
Austrian winter peas	64	97	0	23	41	32	77	34
			1	72	77	62	83	58
			2	83	82	65	82	61
			4	92	81	55	97	64
			6	78	87	54	88	51
			8	70	67	43	53	32
Hairy vetch	192	72	0	21	22	33	44	34
			1	32	30	54	79	66
			2	30	34	57	85	59
			4	39	37	52	91	61
			6	35	35	32	85	46
			8	30	27	24	46	24
Common vetch	119	97	0	53	53	41	49	21
			1	99	91	68	85	68
			2	88	88	86	89	64
			4	79	83	75	95	56
			6	81	77	64	89	42
			8	40	65	46	56	25
Singletary peas (Lathyrus pusillus)	151	52	0	None in 5 days	8		7	
			1		51		14	
			2		52		17	
			4		49		19	
			6		45		8	
			8		12		0	
Bur clover (Burs)	402	85	0	31	95	60	11	10
			1	25	26	29	26	13
			2	13	24	11	48	16
			4	3	11	4	34	11
			6	0	0	0	0	0
			8	0	0	0	0	0
Melilotus Indica	2115	83	0	None in 5 days	34	27	0	0
			1		25	18	0	0
			2		12	5	0	0
			4		0	0	0	0
			6		0	0	0	0
			8		0	0	0	0
Oats	516	93	0	44	25	16	..	..
			1	89	78	82	..	..
			2	77	78	67	..	..
			4	82	68	59	..	..
			6	43	59	27	..	..
			8	2	3	3	..	..

*Only one series counted.

seeded on November 3 in a well-prepared seedbed. One and forty-five hundredths inches of rain fell three days prior to planting. Temperature and moisture conditions were very favorable for germination at the time of planting and for the succeeding week. After this there were three weeks of rather unfavorable weather—nine inches of rainfall and on three different days the temperature was in the low 20's.

Germination counts were made on December 4, and root and inoculation studies on December 24. The main data secured are shown in table 4. As may be observed, the one-inch and two-inch depths of seeding gave the highest percentage of emergence, and the percentage of emergence decreased with each increase in depth of seeding beyond two inches. When plants were dug up for root and inoculation studies, it was found that nodules were larger and more plentiful on the plants from the one-inch and two-inch depths than from other depths. A rather high percentage of plants from the surface planting was inoculated, but the nodules were small and not very numerous. As the depth of planting increased, the percentage of inoculated plants decreased rapidly. The root development of the plants from the one-inch and two-inch depths was considerably better than that of other depths. The root system was poorly developed on the plants from the six- and eight-inch plantings especially. The plants from the one- and two-inch seedings were healthier and more vigorous than from other depths, and the low temperatures killed the above ground portion of fewer of them.

TABLE 4. FIELD GERMINATION AND INOCULATION OF PLANTS IN COVER-CROP DEPTH OF PLANTING EXPERIMENT—CALHOUN—1940

Depth of seeding	Percent germination	Percent inoculated
Surface	33.1	85.7
1 inch	87.0	97.7
2 inches	89.4	93.2
4 inches	62.5	56.6
6 inches	49.1	31.6
8 inches	26.3	7.7

In 1941 another depth of planting experiment was conducted at Calhoun similar to the one in 1940 except that plantings were made of the seed of seven different crops. With the exception of bur clover, the crops used and results obtained are listed in table 5. The plantings were made October 15 on a rather moist seedbed. Immediately after planting rains set in and continued through October, a 6.87-inch rain falling on October 31. Rains continued into November. Counts were made on November 19, giving results as shown in table 5. Bur clover seed were planted also but were apparently non-viable as none germinated.

TABLE 5. Depth of Seeding Winter Cover Crops—Calhoun—1941

Crop	Depth in inches	Number of Plants						% Germ.
		Series					Average	
		I	II	III	IV	Total		
Common vetch	Top	46	12	42	32	132	33	19.8
	1	158	155	157	166	636	159	95.2
	2	119	148	157	150	574	144	86.2
	4	129	138	156	137	560	140	83.8
	6	105	81	110	90	386	97	58.0
	8	21	35	34	98	188	47	28.2
Hairy vetch	Top	96	33	49	44	222	56	14.9
	1	282	285	280	305	1152	288	76.6
	2	267	311	268	266	1112	278	73.9
	4	257	214	215	180	866	217	57.7
	6	255	285	201	213	954	239	63.6
	8	64	40	89	172	365	91	24.2
Singletary peas (Lathyrus pusillus)	Top	60	37	81	55	233	58	14.0
	1	144	168	148	129	589	147	35.5
	2	128	161	110	126	525	131	31.6
	4	106	90	81	55	332	83	20.0
	6	98	62	92	63	315	79	19.1
	8	14	11	16	25	66	17	4.1
Willamette vetch	Top	37	30	55	44	166	42	22.9
	1	159	177	177	184	697	174	95.1
	2	162	61	78	169	470	118	64.5
	4	152	162	150	148	612	153	83.6
	6	121	103	139	131	492	124	67.8
	8	68	101	127	123	419	105	57.4
Oats	Top	140	135	131	191	597	149	41.7
	1	320	318	319	308	1265	316	67.5
	2	278	302	209	318	1107	277	77.6
	4	150	75	77	102	407	102	28.6
	6	0	0	0	0	0	0	0.0
	8	0	0	0	0	0	0	0.0
Austrian winter peas	Top	22	13	24	21	80	20	19.2
	1	89	93	96	101	379	94	90.4
	2	96	97	98	106	397	99	95.2
	4	88	82	95	84	349	87	83.7
	6	86	88	85	90	349	87	83.7
	8	86	57	72	67	232	58	55.8

Another depth of planting cover-crop seed experiment similar to the one in 1941 was conducted at Calhoun in 1942. This year two additional crops, Creole peas and bur clover, were included. Results are shown in table 6. Planting was done on November 4 and counts made on December 31.

In 1942 the soil contained only a small amount of moisture at planting and practically no rain fell for three weeks, relatively high tempera-

TABLE 6. DEPTH OF SEEDING WINTER COVER CROPS—CALHOUN—1942

CROP	Depth in inches	1941 Percent germination	1942 Percent germination	2-year average Percent germination
Creole peas	Top		17	
	1		89	
	2		87	
	4		83	
	6		82	
	8		62	
Austrian winter peas	Top	19	5	12
	1	90	92	91
	2	95	92	94
	4	84	85	85
	6	84	86	85
	8	56	77	67
Common vetch	Top	20	4	12
	1	95	96	96
	2	86	89	88
	4	84	86	85
	6	58	59	59
	8	28	56	42
Willamette vetch	Top	23	9	16
	1	95	85	90
	2	65	82	74
	4	84	79	82
	6	68	59	64
	8	57	33	45
Hairy vetch	Top	15	25	20
	1	77	64	20
	2	74	65	71
	4	58	50	54
	6	64	21	43
	8	24	15	20
Singletary peas (Lathyrus pusillus)	Top	14	3	9
	1	36	37	37
	2	32	39	36
	4	20	28	24
	6	19	21	20
	8	4	18	11
Oats	Top	42	65	54
	1	68	95	82
	2	78	87	83
	4	29	77	53
	6	0	27	14
	8	0	2	1
Bur clover (Burs)	Top		82	
	1		23	
	2		13	
	4		0	
	6		0	
	8		0	

tures prevailing during the period. These conditions were just the opposite of the ones prevailing after planting in 1941, yet results are very similar. In all cases, excepting the bur clover which gave its best germination from surface planting, the one- and two-inch seedings gave best emergence and there was a decided reduction in emergence as the depth of planting increased. However, the four-inch depth gave slightly better emergence, relatively, in 1942, a dry year, than in 1941, a wet year.

Depth of Planting Cover-Crop Experiment at St. Joseph—1940:

A depth of planting cover-crop experiment using common vetch seed was run on the Northeast Louisiana Experiment Station farm in Tensas Parish at St. Joseph, Louisiana, in 1940. Seeding was done on October 14 at the five different depths shown in table 7 and was done in very dry Sarpy very fine sandy loam soil. Field germination counts were made on November 2, 6, 28 and on January 8, and percentages determined. The slight reduction in number of plants on January 8 was probably due to the destruction of a few of the plants by pests. As may be seen from table 7, the optimum depth of coverage was 2 inches, but the 4-inch depth was not far behind. As has been noted in the other experiments, the percentage of plant emergence decreased as the depth increased beyond 4 inches.

TABLE 7. Depth of Planting Common Vetch at St. Joseph—1940

Depth	Percent Germinated			
	November 2	November 6	November 28	January 8
Surface	0.0	68.0	79.0	77.3
2 inches	17.3	79.0	89.0	86.3
4 inches	69.0	77.0	79.0	83.0
6 inches	29.0	50.0	60.0	59.3
8 inches	25.0	40.0	52.0	45.7
Average	28.1	62.8	71.8	70.3

Methods of Planting Winter Cover-Crops

Methods used in planting winter cover-crops vary depending on the type of farming carried on. On large farms where much tractor work is done, the machinery used will naturally be different and larger than that used on small farms. In the following discussion the experiments conducted at the experiment stations will be mentioned and also approved practices in use on some of the larger farms.

Methods of Planting Experiments at Baton Rouge

At Baton Rouge the experiments were conducted on medium-fertile Olivier soil on second bottom land for a three-year period. No fertilizer was applied to the cover crops, but the preceding cotton crops were fertilized with a complete fertilizer. The equipment used was such as the ordinary two-horse farmer might be expected to have. Four different methods of planting were tried. These are designated as treatments 1, 2, 3, and 4 and may be explained as follows:

1. Seed broadcasted in cotton middle and a middle burster run in the middle. This lifted most of the seed to the side of the old ridge or bed and covered them at various depths ranging from 0 to 6 inches. The cost of seed and labor for this method of planting was estimated at $2.12 per acre, prewar prices.

2. Treatment 2 was like 1 except that the burster was run in the old ridge instead of in the middle. This placed most of the seed at the bottom of a new bed and covered them four to ten inches. The cost was $2.12 per acre.

3. In treatment 3, a bar furrow was run on each side of the old cotton ridge with a turning plow, the seed drilled in this, then a middle burster run in the old middle to cover them. This method of planting cost about $3.72 per acre and was considerably more labor-consuming than any of the others.

4. In treatment 4, a large middle burster was run in the old cotton ridges, thus making new ridges of some size. The tops of these new ridges were smoothed off with a drag and seed planted on them with a three-hose grain drill. This method planted and covered the seed more uniformly than the others and gave better stands. It cost about $3.00 per acre.

The same rate of seeding was used for all the treatments but varied for the different crops as follows: Austrian winter peas, 35 pounds per acre; hairy vetch, 25 pounds; common vetch, 35 pounds; giant bur clover, 8 bushels; Melilotus Indica, 20 pounds.

Planting was done each year during the second half of October and samples of plants from measured areas cut and weighed during the latter part of March. This was the usual time for turning under winter-cover-crops.

TABLE 8. Methods of Planting Winter Cover-Crops, Baton Rouge—1941
—Pounds of Green Matter Obtained Per Acre—

Crops used	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Comparative weight of crops grown
Austrian winter peas..	10,133#	7,083#	11,450#	16,300#	11,242#
Hairy vetch..........	3,116	4,033	4,833	10,433	5,604
Common vetch.......	4,466	5,616	6,583	15,150	7,951
Bur clover...........	9,583	1,516	6,033	22,866	9,999
Melilotus Indica......	7,350	5,300		16,600	

In 1941 samples were cut on all plots on March 28. The green weights obtained are shown in table 8. It will be observed that treatment 4 produced the greatest weight and that Austrian winter peas gave the largest crop yields.

In 1942 green weight samples were cut on all plots on March 30. Weights obtained are shown in table 9. This year treatment 1 gave the heaviest growth. Treatment 4 usually gives best growth, but failed to this year largely because of the poor condition of the soil at planting time. There was much grass on the plots and the ground was so hard and dry that the middle burster did not make a satisfactory ridge.

TABLE 9. METHODS OF PLANTING WINTER COVER-CROPS, BATON ROUGE—1942
—POUNDS OF GREEN MATTER PER ACRE—

CROPS USED	AVERAGE WEIGHT				Comparative weight of crops grown
	Treatment 1 3 series	Treatment 2 3 series	Treatment 3 3 series	Treatment 4 3 series	
Austrian winter peas..	11,240#	9,320#	9,820#	9,060#	9,860#
Hairy vetch..........	10,220	9,200	10,920	9,160	9,875
Common vetch.......	11,620	11,540	10,520	6,260	9,985
Bur clover...........	11,700	13,200	9,900	12,760	11,890
AVERAGE FOR TREATMENT........	11,195	10,815	10,140	9,310	

In 1943 also green weight samples were cut on March 30. There was fair growth at that time. Weights are shown in table 10. Treatment 4 here is significantly higher in weight than any of the other treatments and it leads by a considerable margin in the three-year average. Of the crops grown, on the three-year average, bur clover and Austrian winter peas lead by a fair margin.

TABLE 10. METHODS OF PLANTING WINTER COVER-CROPS, BATON ROUGE—1943
—POUNDS OF GREEN MATTER PER ACRE—

CROPS USED	AVERAGE WEIGHT				1943 Comparative weight of crops grown	3-yr. average weight of crops grown
	Treatment 1 3 series	Treatment 2 3 series	Treatment 3 3 series	Treatment 4 3 series		
Austrian winter peas	7,843#	6,776#	6,963#	10,153#	7,934#	9,679#
Hairy vetch.......	7,733	6,820	6,776	12,210	8,385	7,952
Common vetch....	7,073	6,160	6,710	10,890	7,708	8,549
Bur clover........	7,777	5,236	7,216	10,483	7,678	9,856
Average for treatment, 1943..	7,607	6,248	6,416	10,934		
3-yr. av. for treatment.......	8,542	7,208	7,927	12,143		

Methods of Planting Experiments at Calhoun

Methods of planting cover-crop experiments similar to the ones carried on at Baton Rouge were conducted at Calhoun in 1941 and 1942. Ruston sandy loam soil was used without fertilizers either on the vetch used as a cover-crop or on the cotton that followed. On account of this lack of fertilizer yields are naturally low. Rainfall and other weather conditions at Calhoun for the two years were mentioned in the preceding depth of planting discussion.

Yields of vetch and seed cotton are shown in table 11. It will be observed that under the conditions of the experiments there does not seem to be any significant difference in yields of either vetch or seed cotton due to the different methods of planting.

TABLE 11. COTTON FOLLOWING VETCH PLANTED BY DIFFERENT METHODS AT CALHOUN

METHOD	TONS GREEN MATTER PER ACRE*			LBS. SEED COTTON PER ACRE		
	1941	1942	2-yr.av.	1941	1942	2-yr.av.
Broadcast seed in old middle, then break out the middle with a middle burster........	3.0	4.1	3.6	424	612	518
Broadcast seed in old middle, then break out the old row with middle burster.........	2.9	3.3	3.1	475	573	524
Bar off each side of old row with a turning plow, sow seed in furrows left by turning plow; then cover seed by running middle burster in old middle........................	2.9	2.9	2.9	519	536	528
Chop old stalks and run through the old row with middle burster; flatten ridge and plant drill row on top thereof....................	3.4	2.7	3.1	544	499	522

*Green weights of vetch taken April 19, 1941, and April 22, 1942.

CURRENT PRACTICES IN SEEDING WINTER COVER-CROPS *IN* LOUISIANA

On the preceding pages were given the results from certain experiments in cover-crop culture. Farmers in different sections of the State follow practices more or less similar to those outlined. It may be of some interest to mention briefly some of the methods being used in practical work in certain parts of the State.

A survey of methods of planting winter legumes for soil improvement in North Louisiana shows that there are two practices significantly important in growing the crop satisfactorily, planting the seed early—late September or early October, and covering them with approximately two inches of soil.

The methods of planting used in the area are well covered in the four methods making up the experiments on methods of planting reported herein. The particular implements used for different planting operations vary with individual farmers. Relatively few farmers in the area use a planter to plant a single drill of seed on the top of a well-prepared seedbed in regular width rows. The other three methods described are used widely. However, failure is often associated with one of the methods; namely, sowing the seed broadcast (on current year cotton land), then breaking out the old middle with a middle burster. The criticism of this method of planting is that the seeds frequently are not covered deep enough to be in contact with sufficient moisture to germinate when a dry period follows planting. Also, in the case of a heavy rain before germination, many of the seed may be left exposed due to the loose soil on the "shoulders" of the old row being washed to the middles. Under these circumstances seed are also washed into the "sand-packed" middles where growing conditions are unfavorable. Data given on this method of planting in table 11 do not indicate that these unfavorable growing conditions prevailed in the course of the experiment on different methods of planting vetch at Calhoun. This was probably due to particular caution being given to covering the seed in this method of planting.

Success in growing winter legumes was more often reported by farmers who followed the practice of broadcasting the seed in the old middle, then breaking out the old row with middle burster or the method of barring off each side of old row with a turning plow (or perhaps using a widened Planet Jr. cultivator to accomplish same effect), sowing seed in furrows left by turning plow, then covering seed by running middle burster in old middle. Middle bursters used in the hill area of North Louisiana are designed for relatively shallow plowing. Their wings are rather short and do not move the soil with the force of bursters built for heavier soils. Consequently, seed sown broadcast and covered by breaking out old row with middle buster are not covered as deep as commonly thought. With this method of planting the most of the seed is covered with two to four inches of soil, the depth range shown to be most satisfactory in the depth of planting experiments discussed in this report.

Where fertilizer is used in the fall for the winter legume crop, it is ordinarily applied in the middle with a one-row mule drawn distributor and the legume crop is planted by broadcasting the seed in the old middle, and breaking out the old row with middle burster. This method of planting is generally preferred and is probably most satisfactory on farms of limited equipment. It is usually helpful to cut the stalks of the previous crop before planting the winter legume crop, because these stalks may interfere with the middle burster operation in covering the seeds and with the plowing under of the legume crop in the spring.

In Louisiana Delta

The several methods of planting vetch in the Delta section of Louisiana are listed below in the order of acreage of each.

First, the old cotton plants are turned under with tractor or 4-mule middle burster and the seed are drilled on top of the new row thus formed. Probably 60 per cent of the acreage of vetch is planted in this manner. The advantages of this method are that the cotton stalks are turned under for the winter and the vetch is on sufficient row to insure drainage. The disadvantages are that the vetch has no protection from cold weather and has no support to cling to when growing. Growth is apparently somewhat slower in fall when planted in this way but the final growth in spring is usually ample. The type of planters used varies from 4-row tractor to 1-mule, most of the acreage being with 2-row tractor or mule type.

Second, seed are distributed by end-gate seeder. Following distribution of seed two methods are used in covering: (a) tractor disk is run over the land cutting the old cotton stalks to a certain extent, leveling the land somewhat and covering the seed; and (b) tractor middle burster, either 2- or 4-row type, is run, breaking out the old rows. The advantages of this type of planting are that it gives a rather uniform distribution of the seed over the entire land area and planting may be done more rapidly. The disadvantages of the method are that, where the covering is done by middle burster some seed are left too deep, and when covered by disk some seed are left in the old cotton middles where drainage is poor. On the whole, however, this method has proven very satisfactory, especially when the vetch is to be grazed by cattle.

Third, the vetch seed are sown, either by end-gate seeder or by hand, in the old cotton stalks and mule-drawn middle burster is run down the old middles, thus throwing the seed up on the sides of the rows and covering them at the same time. This method is used quite extensively by the small farmers who are not equipped with large implements. It has proven very successful, a disadvantage being that in case of heavy rain soon after seeding many seed washed down into the middles or, if germination has already taken place, many of the small plants are left with roots exposed.

Fourth, small vetch planters are used. These planters are usually one-mule type, having duplex hopper, opening shovels, and small middle burster attachment for covering. These planters do good work, seeding uniformly and getting the seed well on the side of the old cotton row where drainage is good. The disadvantages are that the method is slow and implement somewhat too heavy draft for one mule.

Some trials have been made planting vetch with airplane but to date this method has not been fully satisfactory, lack of uniform stands being the most common criticism. This method of planting holds considerable promise as it would enable the farmers to get the vetch in early and not have to wait until the cotton harvest was complete. It is possible that better stands would result if the planting could be done immediately following heavy fall rains.

On the small farm area of southcentral Louisiana, comprising parts of St. Landry, Lafayette, Avoyelles, and Rapides Parishes and surrounding areas, vetches are planted most commonly as cover-crop plants, common vetch being the most popular. The seed are usually sown broadcast and covered by a middle burster run in the old middles. This not only covers the seed but puts them on a ridge where there is drainage.

On the rice lands of the southern prairies of the State hairy vetch is commonly sown in oats as a winter cover-crop. This not only serves to cover the land but affords considerable pasturage. The land is well prepared by discing or flatbreaking and seed sown with grain drill. This method insures that the seed will be well planted in respect to depth and spacing, but the winter drainage may not be so satisfactory in spots. Good drainage is necessary for proper growth.

Winter cover-crops are used extensively on the sugarcane farms in southeast Louisiana. The crop is usually planted in plant cane fields in September or October. Seed are sown by hand broadcast, or with a cyclone seeder, or they may be drilled in on each side of the cane row with a corn planter. In the lower part of the area where soils are not acid Melilotus Indica is used most generally because it tends to make greater tonnage to turn under than other crops. Farther north in the cane belt where the soils are somewhat acid vetch and Austrian winter peas are grown.

SUMMARY

1. The results from the depth of planting experiments were very consistent although carried on in rather widely separated sections of the State, on different soil types, and with considerable differences in soil moisture.

2. In most instances the two-inch depth gave the optimum plant emergence, but there was not much difference between the one-, two-, and four-inch depths.

3. A coverage greater than four inches resulted in a lower plant emergence, poorer root development, and weaker plants.

4. The number of plants inoculated decreased with depths greater than four inches. There were also fewer nodules on the individual plants from greater depths and they were smaller.

5. The bur clover and Melilotus Indica seeds gave best germination from surface planting, and practically no emergence from depths greater than two inches. Seed of these crops should be covered very lightly, if at all.

6. In south Louisiana planting cover-crop seed with grain drill on ridges made by middle burster gave, in most instances, greater tonnage

of green matter than any other method. This method of planting provides for more uniform seeding and coverage than the other methods mentioned and there is better winter drainage.

7. Broadcasting the seed and covering them with a middle burster run in the old middles is a simple method of planting cover-crop seed, and it gives good results in south Louisiana.

8. Broadcasting vetch or Austrian winter pea seed in the old middles then covering them with middle burster run in the old row, or drilling in bar furrow on each side of old ridge and covering with middle burster run in the old middles has given satisfactory results in north Louisiana.

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WEATHER OBSERVATIONS AT THE RICE EXPERIMENT STATION, CROWLEY, LA., FOR THE THIRTY-THREE-YEAR PERIOD 1910 TO 1942, INCLUSIVE

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS
W. G. TAGGART, *Director*

WEATHER OBSERVATIONS AT THE RICE EXPERIMENT STATION, CROWLEY, LA., FOR THE THIRTY-THREE-YEAR PERIOD 1910 TO 1942, INCLUSIVE[1]

BY J. MITCHELL JENKINS[2]

INTRODUCTION[3]

The year following the establishment of this Station, weather instruments were installed for the purpose of recording certain climatic conditions under which field experiments with rice are conducted, and for the purpose of accumulating weather data in the vicinity of Crowley, which is located in the principal rice growing area of the United States.

Success in growing rice in Louisiana is dependent largely upon the local weather conditions. It is essential that the weather is fair in the spring for seeding; that there is an adequate supply of fresh water for irrigation purposes in the spring and summer; and that the weather is good in the fall at harvest time. From 60 to 75 per cent of the irrigation water for rice is obtained from streams that get their supply mainly from local rains. The balance is obtained from deep wells.

INSTRUMENTS AND THEIR LOCATION

The weather instruments occupy an inclosure in an open space in the field about one-quarter of a mile from the Station buildings. They include maximum and minimum thermometers for recording air temperatures; an evaporation tank to determine evaporation from an unobstructed surface; an anemometer to record the wind movement; a psychrometer to determine relative humidity and vapor pressure; and a rain gauge for the purpose of recording precipitation.

The maximum and minimum thermometers for recording air temperature, and the psychrometer are located in an instrument shelter, two feet from the ground, with a double-top and slatted sides. The anemometer was placed only two feet above the ground to record the wind velocity at a height lower than that of most mature rice plants.

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[3] The writer is indebted to Mr. Charles E. Chambliss, retired; who was in charge of Rice Investigations, United States Department of Agriculture, when the Station was established, and continued in that capacity until December 31, 1930, and was responsible for the installation of the instruments; for his guidance in placing the instruments, and recording the data. The writer is also indebted to the Biophysical Laboratory, Bureau of Plant Industry, Soils & Agricultural Engineering, for the instruments, instructions regarding their care, and the compilation of records.

The evaporation tank is 72 inches in diameter and 29 inches in depth. It is placed in the ground to a depth of approximately 23 inches, and is equipped with an outside well in which readings are taken with a screw micrometer gauge. The tank is equipped with floating thermometers for the purpose of recording maximum and minimum temperatures just below the surface of the water.

THE DATE READINGS BEGAN, AND THE DAILY HOUR AT WHICH THEY WERE RECORDED

The reading of all instruments was begun April 1, 1910, and with the exception of the psychrometer, which was discontinued after the 19th year, they have been read continuously since that date.

Readings were taken at a given hour each day, and the records indicate the nature of the weather for the preceding twenty-four hours.

SUMMARY

Temperatures

The highest maximum temperature for the thirty-three years, of 103 degrees, occurred on June 27, 1930, and August 10, 1935. On only nine days during that period did the temperature reach 100 degrees or above. In the same period the annual maximum temperatures occurred in June 12 years, July 11 years, August 9 years, and in September 1 year.

The minimum temperature for the thirty-three years was 9 degrees and occurred on January 12, 1918. In all other years the lowest minimum ranged from 16 degrees, January 19 and 20, 1940, to 31 degrees, December 5, 1921. In the same period the annual minimum temperatures occurred in January 14 years, February 4 years, March 1 year, November 3 years and in December 11 years.

The months with the highest thirty-three year average maximum temperatures were June 89, July 90, August 91 and September 88 degrees. The months with the lowest average maximum temperatures were January 63, February 66 and December 64 degrees. The months with the lowest average minimum temperatures were January and December each with 44 degrees and February 46 degrees. The months with the highest average mean temperatures were July and August each 82 degrees and June 81 degrees. The months with the lowest average mean temperatures were January and December each 54 degrees and February 56 degrees.

Precipitation

There was a decided range in the average precipitation for the different months, each month, however, except February, in one or more years had the highest monthly rainfall. The record was held by January 3 years, March and April 1 year each, May 4 years, June 2 years, July 7 years, August 4 years, September 2 years, October, November and December each 3 years. In monthly total average rainfall, for the thirty-three year period, from highest to lowest, the months ranked in the order named, August, July, December, January, May, June, November, September, February, March, April and October.

The spring months with the lowest average rainfall were March and April with only a difference of .10 of an inch. The fall months with the lowest average precipitation were October and September in the order named, closely followed by November. The highest total rainfall for any one month was 37.46 inches, recorded in August, 1940. The only month without rain was October, 1924. The highest annual precipitation, 106.40 inches, was for the year 1940; and the lowest, 30.58 inches, was for the year 1924.

Evaporation

The months with the highest average evaporation for the thirty-three year period were June, May, July and August, in the order named. The average evaporation exceeded the average precipitation in May by .95 of an inch, and in June by 1.16 inches. For July the average precipitation exceeded the average evaporation by .51 of an inch, and for August by .67 of an inch. For the entire period the average total annual precipitation exceeded the average total annual evaporation by 6.52 inches. In the same period the difference between the highest and lowest annual precipitation was 76.06 inches, but between the highest and lowest annual evaporation the difference was only 13.54 inches. If the total annual precipitation were as constant as the evaporation, the rice farmer would not have the anxiety he frequently experiences from the lack of irrigation water due to long periods of dry weather during the irrigation season. Unfortunately, it is during such periods and always during the time water is needed most that evaporation is highest and the precipitation is apt to be too low to offset the extreme evaporation. Fortunately, extremely dry weather is seldom of sufficient duration to cause extreme damage or a total crop failure.

Ice, Snow and Frozen Rain

In the thirty-three years the latest ice in spring was recorded on April 5, 1915 and a low temperature of 33 degrees was recorded as late as April 25, 1910. The last ice in spring for the 32-year period (1911-1942) occurred in January 3 years, February 15 years, March 12 years, April 1 year and none in 1921.

For the same period, the earliest ice in the fall was recorded on October 20, 1917. The first ice in fall, in the thirty-three years, occurred in October 3 years, November 20 years, December 7 years, with none for the years 1922, 1931 and 1933.

The heaviest snow recorded in the thirty-three years was two inches February 24, 1914 and the same amount January 22-23, 1926. A little snow fell in the winters of seven other years. Outstanding cold periods occurred in the winters of 1918, 1929 and 1940. In those years, rain and sleet accompanied by low temperatures caused a thick coating of ice to form on all exposed objects resulting in much damage to trees, shrubbery and telephone poles.

TABLE 1. CONDENSED WEATHER RECORD FOR THE MONTH OF JANUARY, 1911 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1911	60	70	50	78	18	4	3.50	5	1.406	....	5.5
1912	47	57	37	75	19	11	6.99	10	1.966	....	4.1
1913	57	68	47	79	28	1	5.63	9	1.551	....	4.5
1914	54	66	42	78	26	5	0.96	11	2.053	....	3.4
1915	52	62	41	75	27	5	6.62	7	1.306	....	3.9
1916	59	68	51	78	26	4	6.68	13	2.018	....	5.3
1917	56	65	46	80	27	3	4.05	9	1.662	....	4.9
1918	44	56	32	74	9	19	6.10	14	2.193	....	5.4
1919	50	59	40	72	22	10	6.36	8	1.483	....	2.6
1920	56	63	52	80	30	1	6.97	12	0.964	57	4.3
1921	58	69	51	77	34	0	2.79	8	2.116	50	3.5
1922	53	61	45	79	31	2	6.38	16	2.598	55	4.3
1923	59	69	48	78	34	0	5.19	8	2.133	62	3.2
1924	48	59	38	72	18	8	6.72	14	1.993	53	3.8
1925	56	63	42	78	31	4	5.01	13	3.183	56	3.2
1926	50	59	41	73	29	8	7.47	13	1.708	54	3.2
1927	59	69	48	80	25	5	1.18	8	2.325	60	3.3
1928	51	62	41	79	19	7	0.94	10	2.137	54	3.1
1929	55	65	45	78	24	7	5.50	14	2.227	58	5.6
1930	51	60	42	75	19	8	9.66	12	2.052	56	5.4
1931	51	61	41	73	30	3	8.44	9	2.108	55	3.4
1932	59	67	51	80	35	0	9.58	12	2.620	63	4.9
1933	58	67	49	76	29	2	3.57	11	2.546	62	3.4
1934	56	64	47	77	27	2	7.72	15	2.263	61	3.3
1935	55	65	44	80	20	5	2.40	9	2.464	60	4.2
1936	50	60	41	75	25	8	2.95	16	2.055	55	4.2
1937	60	67	52	79	41	0	9.73	21	2.159	63	5.9
1938	53	62	44	78	29	3	4.68	9	4.102	57	4.8
1939	56	65	46	77	31	1	2.92	12	2.561	59	4.9
1940	40	49	30	71	16	22	2.29	8	2.483	50	4.0
1941	54	64	45	82	27	2	4.97	11	2.630	58	3.3
1942	48	60	36	74	22	9	4.90	9	2.554	54	3.4
TOTAL	1715	2021	1405	2460	828	169	168.85	356	69.619	1312	132.2
Ave..	54	63	44	77	26	5	5.28	11	2.176	57	4.1

TABLE 2. CONDENSED WEATHER RECORD FOR THE MONTH OF FEBRUARY, 1911 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1911	62	73	51	85	25	5	1.21	2	2.892	....	4.9
1912	49	61	37	74	24	9	4.64	9	2.994	....	5.0
1913	52	63	41	75	27	2	2.78	6	2.603	....	3.8
1914	51	61	41	77	27	7	5.01	9	2.246	....	4.2
1915	56	66	45	....	....	..	7.33	7	2.425	....	4.4
1916	55	67	44	79	27	6	1.66	7	2.695	....	4.2
1917	56	67	45	82	23	6	3.52	7	2.560	....	4.7
1918	60	69	51	79	30	3	2.95	13	2.201	....	5.4
1919	56	65	47	76	33	0	6.39	14	2.552	....	4.5
1920	59	67	48	75	34	0	5.37	6	2.226	57	3.5
1921	63	70	46	79	34	0	2.25	12	2.966	59	3.8
1922	60	70	50	79	30	2	5.17	12	2.351	61	3.9
1923	56	65	46	79	29	6	4.88	10	1.867	60	4.6
1924	53	65	44	78	26	1	3.95	8	2.654	58	4.2
1925	65	71	49	80	30	1	1.77	9	3.003	62	3.7
1926	57	68	45	75	32	2	2.83	7	2.759	62	3.3
1927	62	72	54	81	38	0	7.44	13	2.535	67	3.2
1928	56	63	45	78	31	2	5.14	10	2.961	58	4.3
1929	52	61	41	78	28	4	5.47	12	2.115	55	5.4
1930	61	69	51	77	31	1	5.24	10	2.413	64	4.2
1931	58	68	47	78	34	0	3.29	10	2.539	61	4.0
1932	65	73	57	81	35	0	5.05	10	2.376	68	4.2
1933	57	65	47	78	19	4	3.90	17	2.082	61	5.0
1934	55	66	45	75	29	2	3.76	7	3.009	61	5.0
1935	56	66	45	76	26	3	5.28	7	3.092	60	4.5
1936	50	59	40	79	27	7	4.11	11	2.464	54	5.0
1937	54	63	45	77	28	2	1.68	12	2.804	58	5.6
1938	59	69	50	79	28	2	2.65	11	2.625	62	4.7
1939	55	64	46	79	28	2	2.51	13	2.912	60	6.6
1940	51	59	43	70	31	1	7.00	11	2.276	53	5.2
1941	51	59	42	75	30	3	2.62	8	2.518	56	4.8
1942	51	60	41	75	29	7	4.57	11	2.531	57	4.9
TOTAL	1803	2104	1469	2408	903	90	131.42	311	82.246	1374	144.7
Ave...	56	66	46	78	29	3	4.11	10	2.570	60	4.5

TABLE 3. CONDENSED WEATHER RECORD FOR THE MONTH OF MARCH, 1911 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1911	65	77	52	93	40	0	2.53	8	3.951	....	3.9
1912	58	69	48	81	35	0	4.24	17	3.305	....	4.7
1913	59	70	49	82	31	2	2.60	4	3.010	....	4.5
1914	56	66	46	80	29	4	7.13	14	2.815	....	3.6
1915	54	65	43	77	25	3	2.43	7	3.489	....	4.4
1916	63	75	50	85	30	1	0.34	4	4.297	....	5.3
1917	62	74	51	82	27	2	3.67	8	3.893	....	5.3
1918	67	77	56	85	43	0	3.44	6	4.146	....	3.6
1919	62	74	50	82	38	0	1.49	7	3.293	....	4.0
1920	64	69	50	81	30	3	1.62	7	2.959	64	5.6
1921	69	78	58	85	40	0	3.63	10	3.927	69	4.3
1922	60	71	49	81	30	2	6.31	15	3.726	65	5.4
1923	60	70	50	83	27	3	7.94	12	3.723	64	5.1
1924	57	71	47	81	32	3	2.29	7	3.154	62	5.3
1925	70	76	52	85	33	0	3.52	7	4.593	66	3.5
1926	57	66	49	78	35	0	11.51	14	3.621	63	4.3
1927	62	72	51	83	34	0	5.20	10	3.792	67	3.6
1928	63	72	54	82	37	0	3.88	15	3.284	67	4.7
1929	64	74	54	84	31	1	5.67	6	3.464	67	7.0
1930	58	67	49	78	30	1	2.26	13	3.396	62	3.8
1931	55	66	44	76	33	0	3.29	9	3.860	59	5.1
1932	57	67	46	80	27	5	1.74	8	4.008	63	5.4
1933	63	72	54	82	36	0	6.93	7	4.021	66	5.4
1934	60	71	48	80	32	1	5.72	9	3.968	65	5.1
1935	66	74	56	85	33	0	4.32	8	3.813	68	6.0
1936	64	74	54	86	41	0	1.21	8	3.442	67	4.3
1937	56	65	47	79	28	2	3.50	11	3.279	61	4.6
1938	68	77	58	84	42	0	1.04	9	3.601	70	5.5
1939	63	72	53	84	40	0	1.84	7	4.475	68	5.3
1940	61	71	50	83	37	0	5.38	4	4.160	64	4.3
1941	54	63	45	76	33	0	8.24	10	3.426	58	4.9
1942	56	64	47	79	33	0	4.93	10	3.409	61	5.2
TOTAL	1953	2269	1610	2622	1072	33	129.84	291	117.300	1486	153.0
Ave...	61	71	50	82	34	1	4.06	9	3.666	65	4.8

TABLE 4. CONDENSED WEATHER RECORD FOR THE MONTH OF APRIL, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1910	66	80	52	87	34	0	1.59	5	5.656	....	4.5
1911	71	81	61	88	49	0	5.99	10	5.824	....	5.0
1912	70	78	61	88	42	0	4.50	10	4.030	....	4.1
1913	65	77	53	85	40	0	4.66	6	5.065	....	4.2
1914	68	77	58	86	37	0	5.59	10	3.981	....	4.0
1915	67	79	55	93	32	1	0.28	5	4.668	....	4.3
1916	65	77	53	85	34	0	2.46	8	4.755	....	3.9
1917	66	77	55	86	40	0	2.53	7	4.919	....	4.7
1918	66	76	57	85	38	0	7.91	11	4.180	....	4.0
1919	67	78	55	88	42	0	4.90	9	4.827	....	3.4
1920	68	78	56	89	35	0	3.28	5	3.174	72	6.0
1921	67	77	55	84	39	0	4.49	7	4.939	69	3.8
1922	71	81	61	86	46	0	1.58	6	4.838	74	4.9
1923	69	77	60	86	42	0	5.40	13	3.284	74	4.0
1924	69	76	59	87	37	0	2.74	8	4.299	70	3.9
1925	77	85	59	90	47	0	2.51	6	4.961	74	3.2
1926	66	76	56	81	39	0	7.68	12	3.981	71	3.2
1927	72	82	62	87	42	0	1.86	5	4.238	78	3.7
1928	64	73	53	82	39	0	6.65	10	4.852	68	5.8
1929	72	81	62	88	51	0	1.80	5	5.036	75	6.5
1930	70	82	58	89	49	0	1.32	6	4.487	73	4.0
1931	65	76	57	87	39	0	0.97	10	3.322	69	3.8
1932	68	81	56	88	40	0	2.85	8	5.504	72	4.4
1933	69	79	58	90	41	0	4.26	10	5.234	73	4.8
1934	69	79	58	86	45	0	3.28	9	4.974	75	3.8
1935	69	78	60	85	44	0	3.79	7	5.064	74	4.3
1936	66	77	55	87	36	0	3.91	7	5.146	70	5.8
1937	66	77	53	86	37	0	1.50	4	5.082	73	4.6
1938	67	76	57	88	35	0	4.06	10	5.002	73	5.2
1939	66	75	56	86	34	0	2.83	7	5.771	73	5.3
1940	66	75	58	84	35	0	7.88	9	4.490	71	5.5
1941	70	79	60	85	48	0	4.64	11	5.200	72	4.8
1942	66	74	58	81	36	0	7.87	9	4.643	71	5.0
TOTAL	2243	2574	1889	2853	1324	1	127.56	265	155.426	1664	148.4
Ave...	68	78	57	86	40	.03	3.87	8	4.710	72	4.5

TABLE 5. Condensed Weather Record for the Month of May, 1910 to 1942, Inclusive, at the Rice Experiment Station, Crowley, Louisiana

Year	Temperature, Degrees F.					No. of days with Ice	Precipitation		Evaporation		Wind Velocity
	Monthly Average			Monthly Extreme							
	Mean	Max.	Min.	Max.	Min.		Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
1910	74	85	63	91	51	0	7.61	8	5.862	....	3.7
1911	74	86	62	98	50	0	1.55	5	5.310	....	2.5
1912	75	85	64	93	50	0	4.03	8	5.694	....	2.8
1913	73	84	62	90	54	0	4.01	7	5.973	....	3.0
1914	74	84	65	92	55	0	2.28	9	5.237	....	3.5
1915	75	86	65	94	56	0	4.51	5	5.953	....	4.1
1916	75	86	64	94	51	0	4.90	6	5.784	....	3.1
1917	71	82	60	92	43	0	1.38	5	6.533	....	4.5
1918	74	85	64	91	50	0	1.50	8	6.136	....	3.7
1919	73	83	63	89	50	0	8.02	10	5.423	....	2.6
1920	77	86	68	91	59	0	4.43	7	5.052	85	2.6
1921	73	86	60	96	43	0	1.77	5	6.766	77	2.3
1922	76	86	66	92	55	0	5.59	11	5.911	81	3.1
1923	74	83	63	92	48	0	7.93	11	5.502	80	3.3
1924	73	82	61	91	46	0	1.40	11	5.023	77	2.7
1925	81	87	62	96	46	0	1.51	4	5.839	79	2.5
1926	73	83	63	92	50	0	5.73	8	4.357	77	2.5
1927	78	86	72	91	55	0	14.37	8	4.791	83	3.8
1928	73	85	61	93	46	0	1.06	5	6.131	78	3.3
1929	75	84	65	91	44	0	13.35	10	5.612	76	4.9
1930	76	83	68	87	57	0	4.56	10	5.298	79	4.9
1931	72	82	64	89	49	0	3.01	6	6.774	81	3.6
1932	74	83	64	89	56	0	6.33	10	5.433	76	3.9
1933	78	87	69	93	56	0	5.51	11	6.518	83	4.6
1934	74	84	64	88	52	0	8.33	10	5.921	74	3.8
1935	75	83	66	89	55	0	7.25	6	5.624	81	4.1
1936	75	84	66	89	57	0	6.87	16	5.830	80	3.6
1937	75	86	64	92	57	0	2.89	3	6.655	82	2.9
1938	75	84	66	90	53	0	1.43	4	6.568	80	4.4
1939	75	84	64	88	55	0	3.38	10	5.843	82	3.2
1940	73	83	62	89	54	0	1.09	6	5.715	78	3.6
1941	74	83	65	92	58	0	13.75	11	6.009	81	3.2
1942	74	83	65	90	42	0	1.34	7	5.691	81	4.0
TOTAL	2461	2783	2120	3014	1703	0	162.67	261	190.768	1831	114.3
Ave...	75	84	64	91	52	0	4.93	8	5.781	80	3.5

TABLE. 6. CONDENSED WEATHER RECORD FOR THE MONTH OF JUNE, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1910	78	87	69	92	63	0	8.18	11	5.772	....	2.9
1911	82	93	70	102	65	0	4.81	7	6.887	....	2.3
1912	77	86	69	93	61	0	5.99	9	5.925	....	4.0
1913	78	88	69	97	53	0	3.47	12	5.716	....	2.9
1914	83	93	73	100	68	0	2.48	10	6.835	....	2.2
1915	82	92	71	98	64	0	3.49	10	5.839	....	2.5
1916	80	91	70	96	65	0	1.93	6	6.304	....	2.9
1917	79	91	68	97	55	0	5.63	8	7.651	....	2.5
1918	83	92	73	100	66	0	3.98	12	6.695	....	2.0
1919	79	87	71	94	57	0	4.11	18	4.587	....	2.6
1920	79	88	71	95	64	0	4.52	14	4.946	86	2.1
1921	80	88	71	94	67	0	6.69	15	5.714	79	2.1
1922	81	90	72	97	64	0	3.86	10	5.305	84	1.7
1923	81	89	72	93	66	0	7.05	18	5.290	86	2.3
1924	83	92	74	99	65	0	1.76	8	6.141	85	2.2
1925	83	90	73	96	67	0	5.10	14	6.262	84	2.8
1926	81	90	72	94	61	0	3.20	7	6.373	88	1.9
1927	84	89	73	94	67	0	5.71	14	5.291	87	1.6
1928	80	87	72	91	62	0	5.39	11	5.827	85	3.7
1929	81	90	71	95	65	0	3.53	9	5.894	83	2.2
1930	80	91	69	103	57	0	0.63	3	7.375	84	2.7
1931	81	91	70	95	58	0	1.77	5	5.882	85	2.6
1932	81	89	73	93	66	0	6.74	11	6.866	88	2.9
1933	79	89	68	97	58	0	5.79	6	7.699	85	2.4
1934	82	91	73	94	67	0	4.89	9	6.879	88	2.7
1935	80	88	72	91	66	0	3.37	10	5.750	86	2.7
1936	82	92	73	98	62	0	0.13	3	7.317	85	2.6
1937	82	91	73	96	67	0	2.27	10	5.962	86	2.8
1938	81	89	72	93	64	0	5.17	11	6.128	86	2.7
1939	82	89	74	94	67	0	3.94	15	5.549	89	2.5
1940	79	86	72	92	66	0	12.56	18	5.617	85	3.4
1941	81	87	74	91	68	0	7.27	16	4.936	86	2.9
1942	80	87	73	93	68	0	17.23	16	5.647	86	3.1
TOTAL	2664	2953	2360	3147	2099	0	162.64	356	200.861	1966	85.4
Ave...	81	89	72	95	64	0	4.93	11	6.087	85	2.6

TABLE 7. CONDENSED WEATHER RECORD FOR THE MONTH OF JULY, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME							
	Mean	Max.	Min.	Max.	Min.		Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
1910	81	88	73	93	69	0	9.76	17	5.544	....	2.3
1911	80	87	72	94	65	0	12.39	15	5.552	....	2.2
1912	82	90	73	97	70	0	6.68	11	5.080	....	1.8
1913	82	91	73	98	70	0	4.67	11	5.424	....	2.1
1914	83	91	75	97	69	0	7.28	16	6.123	....	2.2
1915	82	91	73	97	62	0	5.38	10	6.609	....	2.4
1916	81	90	73	95	70	0	7.70	19	5.733	....	2.0
1917	82	90	73	96	70	0	8.85	12	6.022	....	2.4
1918	82	93	71	97	65	0	4.74	7	6.791	....	1.2
1919	82	91	74	95	71	0	6.08	10	5.245	....	1.3
1920	81	89	74	94	70	0	10.56	16	4.388	89	1.3
1921	82	90	79	98	69	0	4.26	12	4.946	87	1.3
1922	82	90	73	95	66	0	4.62	12	5.610	88	1.8
1923	81	88	73	95	68	0	3.50	16	4.897	88	2.1
1924	82	92	69	100	60	0	1.42	4	5.711	88	2.3
1925	84	91	74	95	70	0	2.39	11	5.568	86	2.2
1926	82	91	74	99	67	0	3.68	15	5.531	89	1.6
1927	82	91	74	95	70	0	11.46	16	3.937	85	0.7
1928	82	91	73	96	71	0	3.49	17	5.056	89	1.4
1929	81	89	73	93	71	0	3.70	17	5.530	87	2.2
1930	83	92	74	97	69	0	4.47	8	5.662	87	2.3
1931	83	91	74	97	72	0	4.63	11	6.550	89	2.9
1932	83	91	76	98	71	0	3.62	14	5.175	91	1.7
1933	81	88	74	94	71	0	11.50	17	5.176	87	2.6
1934	82	90	73	100	70	0	7.83	15	6.134	88	2.6
1935	83	91	74	96	71	0	4.95	14	6.031	90	2.1
1936	80	87	74	95	69	0	6.57	12	6.750	88	2.7
1937	83	91	74	95	69	0	5.37	14	6.288	88	2.2
1938	82	90	74	96	72	0	7.82	14	6.606	90	2.1
1939	83	91	74	97	70	0	5.66	14	6.298	89	2.6
1940	81	88	74	94	70	0	5.70	13	5.636	88	2.1
1941	82	89	75	93	71	0	7.76	18	5.641	89	1.7
1942	82	89	74	97	69	0	5.27	15	5.334	89	1.6
TOTAL	2704	2972	2430	3168	2277	0	203.76	443	186.578	2029	66.0
Ave...	82	90	74	96	69	0	6.17	13	5.654	88	2.0

TABLE 8. CONDENSED WEATHER REPORT FOR THE MONTH OF AUGUST, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	Temperature, Degrees F.					No. of days with Ice	Precipitation		Evaporation		Wind Velocity
	Monthly Average			Monthly Extreme			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1910	82	91	74	94	71	0	3.60	9	5.394	....	1.8
1911	81	90	72	96	67	0	7.63	13	5.417	....	2.0
1912	81	89	73	95	66	0	5.59	14	5.750	....	2.1
1913	82	91	73	96	67	0	8.55	13	5.344	....	1.4
1914	81	90	73	94	69	0	3.48	21	4.420	....	1.8
1915	80	89	72	95	63	0	11.07	15	5.972	....	3.4
1916	81	90	73	94	63	0	9.82	10	5.208	....	1.5
1917	81	91	72	96	63	0	2.51	8	5.647	....	1.5
1918	81	90	73	96	69	0	6.01	12	5.709	....	1.6
1919	83	91	75	97	63	0	6.46	12	5.409	....	1.5
1920	81	89	72	92	66	0	9.10	20	5.522	88	1.2
1921	85	91	73	98	67	0	3.04	9	6.501	90	1.3
1922	82	90	73	101	67	0	6.29	13	5.832	88	1.7
1923	82	90	73	94	67	0	3.83	19	5.345	88	1.9
1924	85	94	73	101	67	0	1.80	12	5.869	88	1.7
1925	84	93	71	100	65	0	5.62	10	6.713	87	2.1
1926	82	90	74	97	67	0	5.72	18	4.958	88	1.9
1927	81	90	71	97	61	0	3.73	10	4.961	88	0.9
1928	83	91	74	97	70	0	2.75	12	5.378	86	1.6
1929	82	91	72	94	63	0	2.87	12	6.297	87	2.1
1930	82	90	72	96	63	0	5.33	11	6.285	87	2.3
1931	80	89	72	96	62	0	5.29	11	5.044	87	1.8
1932	83	91	74	94	70	0	6.55	15	5.673	86	1.6
1933	83	91	74	95	70	0	2.72	10	5.059	89	1.5
1934	82	90	74	95	70	0	4.97	12	5.578	89	2.0
1935	84	92	74	103	67	0	7.16	11	5.860	90	2.2
1936	83	92	74	95	67	0	3.62	13	5.700	89	2.0
1937	82	90	73	95	70	0	4.17	12	5.916	88	2.1
1938	82	90	74	96	69	0	6.27	9	5.540	89	1.9
1939	82	91	74	96	69	0	7.29	15	5.925	87	2.1
1940	80	87	72	93	63	0	37.46	13	5.645	87	3.2
1941	84	92	75	96	69	0	3.61	7	6.478	91	1.6
1942	82	91	74	95	68	0	4.76	15	6.058	89	2.5
TOTAL	2709	2987	2412	3169	2198	0	208.67	416	186.407	2026	61.8
Ave...	82	91	73	96	67	0	6.32	13	5.649	88	1.9

TABLE 9. Condensed Weather Record for the Month of September, 1910 to 1942, Inclusive, at the Rice Experiment Station, Crowley, Louisiana

Year	Temperature, Degrees F.					No. of days with Ice	Precipitation		Evaporation		Wind Velocity
	Monthly Average			Monthly Extreme							
	Mean	Max.	Min.	Max.	Min.		Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
1910	79	89	68	93	60	0	3.83	9	4.580	....	1.7
1911	82	91	72	95	67	0	1.89	11	4.139	....	1.5
1912	80	90	70	97	61	0	1.63	7	4.170	....	2.4
1913	76	85	68	95	48	0	13.67	14	3.777	....	2.1
1914	77	87	67	94	52	0	1.78	8	5.145	....	2.2
1915	79	89	69	94	58	0	1.14	7	4.876	....	2.4
1916	76	88	64	94	44	0	2.69	9	5.092	....	1.6
1917	76	86	65	92	54	0	2.29	6	4.835	....	2.0
1918	73	85	61	93	47	0	3.75	8	5.276	....	1.9
1919	78	87	69	91	56	0	3.87	12	5.105	....	2.2
1920	80	90	69	95	46	0	3.66	11	5.253	87	1.7
1921	81	91	71	95	68	0	1.71	12	4.110	85	0.9
1922	78	87	69	92	61	0	7.28	12	4.652	84	1.6
1923	78	88	68	91	59	0	7.77	11	4.369	84	1.3
1924	78	88	65	95	47	0	1.42	2	6.961	76	2.8
1925	82	90	71	94	67	0	7.58	13	4.011	86	1.6
1926	82	90	72	94	62	0	1.91	8	5.238	88	1.8
1927	79	89	67	97	49	0	2.73	10	4.676	85	1.0
1928	75	83	67	94	53	0	4.19	12	4.683	81	2.3
1929	78	88	67	93	57	0	2.40	11	5.443	83	2.4
1930	78	86	70	92	59	0	10.84	14	4.212	83	2.4
1931	80	90	71	95	52	0	1.59	9	5.760	87	1.7
1932	78	87	68	95	55	0	3.92	4	4.803	83	2.5
1933	82	92	72	96	59	0	2.52	9	5.424	87	1.7
1934	77	87	66	92	57	0	3.76	12	5.251	84	2.0
1935	77	86	68	92	52	0	5.40	7	4.842	83	2.1
1936	81	91	71	95	58	0	1.72	9	5.252	86	2.1
1937	78	89	68	95	50	0	2.12	8	5.645	84	2.4
1938	77	88	66	94	52	0	7.80	10	5.440	85	1.8
1939	80	90	69	95	60	0	5.25	8	5.804	86	2.7
1940	76	87	65	94	50	0	3.69	5	6.518	81	3.2
1941	80	87	72	92	65	0	10.04	19	4.693	84	3.4
1942	76	86	66	93	48	0	4.81	7	5.767	82	2.7
TOTAL	2587	2907	2251	3098	1833	0	140.65	314	165.802	1934	68.1
Ave...	78	88	68	94	56	0	4.26	10	5.024	84	2.1

TABLE 10. CONDENSED WEATHER RECORD FOR THE MONTH OF OCTOBER, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. ot Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1910	68	81	55	91	30	3	1.90	8	4.306	....	2.9
1911	70	81	58	93	37	0	5.07	9	4.388	....	2.6
1912	71	83	58	91	41	0	1.55	8	4.004	....	3.2
1913	65	74	56	89	36	0	5.49	12	4.093	....	2.5
1914	68	78	59	89	33	0	3.09	9	3.506	....	2.7
1915	70	82	57	90	41	0	2.64	3	3.883	....	2.0
1916	68	82	55	90	37	0	1.81	4	5.220	....	2.4
1917	64	79	48	91	28	4	0.69	3	4.516	....	2.7
1918	72	81	63	92	45	0	10.36	16	3.794	....	1.7
1919	77	85	68	90	58	0	11.39	21	3.754	....	1.8
1920	66	80	52	87	28	2	5.17	5	3.097	75	2.3
1921	68	82	53	90	35	0	2.93	4	3.371	74	2.2
1922	68	81	55	90	44	0	2.98	8	4.649	74	1.5
1923	67	78	56	92	35	0	2.69	9	4.328	74	3.0
1924	69	85	55	92	35	0	0.00	0	5.860	64	2.5
1925	70	78	60	92	39	0	8.44	15	4.572	77	2.8
1926	74	84	62	92	42	0	4.98	9	3.643	77	2.0
1927	72	85	58	91	38	0	1.92	14	4.042	76	1.5
1928	73	85	61	94	44	0	2.70	6	4.482	77	2.1
1929	70	81	57	88	41	0	3.28	6	4.725	72	3.0
1930	68	78	58	87	38	0	3.06	8	3.738	74	2.8
1931	73	84	62	91	37	0	1.62	8	4.546	79	2.3
1932	67	79	54	88	40	0	5.45	8	4.225	73	2.6
1933	72	83	60	88	41	0	1.92	6	5.159	77	2.4
1934	73	85	61	90	48	0	0.77	4	4.361	78	2.2
1935	72	83	60	89	47	0	0.77	5	4.406	76	2.3
1936	69	81	57	92	45	0	1.57	5	4.734	72	3.1
1937	69	79	57	92	38	0	4.62	12	4.392	73	3.4
1938	71	83	58	93	37	0	0.67	7	4.572	76	2.6
1939	70	81	57	91	37	0	2.30	6	4.803	71	3.1
1940	70	82	57	86	42	0	0.16	2	4.302	73	1.9
1941	76	84	67	90	50	0	6.15	13	4.024	81	2.2
1942	70	82	57	88	39	0	3.82	7	4.731	76	2.2
TOTAL	2310	2689	1911	2979	1306	9	111.96	260	142.226	1719	80.5
Ave...	70	81	58	90	40	.27	3.39	8	4.310	75	2.4

TABLE 11. CONDENSED WEATHER RECORD FOR THE MONTH OF NOVEMBER, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1910	60	71	49	83	30	2	2.42	13	2.668	....	3.2
1911	55	67	43	86	22	7	3.76	14	3.102	....	3.9
1912	56	70	42	82	23	5	0.79	5	2.458	....	2.7
1913	65	77	54	86	33	0	2.09	8	2.249	....	1.9
1914	62	71	53	85	32	1	6.92	9	2.168	....	2.8
1915	63	76	49	88	28	3	2.15	7	3.240	....	2.9
1916	59	74	43	85	21	6	0.36	4	2.999	....	3.9
1917	55	71	38	83	26	7	1.09	2	2.480	....	2.3
1918	58	69	47	80	35	0	6.64	13	2.980	....	2.6
1919	64	75	53	85	34	0	4.88	6	2.932	....	2.4
1920	55	68	41	82	27	4	4.15	8	2.252	58	2.2
1921	65	77	52	85	37	0	3.73	5	2.037	70	2.9
1922	63	74	52	86	34	0	10.23	8	2.963	63	2.7
1923	57	69	44	79	33	0	6.37	8	2.581	62	2.5
1924	63	77	49	87	29	4	2.14	10	3.345	61	2.7
1925	63	70	49	81	30	1	3.36	12	2.456	64	3.0
1926	55	66	44	82	30	1	4.86	10	3.286	61	2.9
1927	66	79	54	87	35	0	3.95	12	2.588	70	1.7
1928	60	72	47	83	29	3	3.13	7	2.770	63	2.9
1929	56	63	48	78	28	1	14.92	14	2.943	62	3.6
1930	59	68	49	82	31	2	4.33	15	1.970	64	3.2
1931	66	77	54	84	36	0	4.78	10	2.844	69	3.7
1932	55	66	40	79	28	6	5.38	7	2.784	59	3.8
1933	62	74	50	83	33	0	1.56	9	3.069	64	2.7
1934	63	74	51	84	35	0	8.61	10	3.583	68	3.1
1935	60	71	48	88	32	1	3.43	5	3.463	65	3.1
1936	58	70	44	88	32	1	5.06	6	4.412	60	3.4
1937	56	67	45	85	27	6	1.36	5	3.258	60	3.8
1938	58	70	46	84	25	8	4.49	7	3.366	64	3.7
1939	57	68	46	82	30	3	2.12	7	2.964	61	3.4
1940	60	68	51	84	27	3	15.25	11	3.428	62	4.1
1941	57	68	45	83	31	2	2.38	9	2.966	63	2.6
1942	62	75	49	85	31	1	0.24	3	3.510	68	3.5
TOTAL	1973	2352	1569	2764	994	78	146.93	279	96.114	1461	99.8
Ave...	60	71	48	84	30	2	4.45	8	2.913	64	3.0

TABLE 12. CONDENSED WEATHER RECORD FOR THE MONTH OF DECEMBER, 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA

Year	TEMPERATURE, DEGREES F.					No. of days with Ice	PRECIPITATION		EVAPORATION		WIND VELOCITY
	MONTHLY AVERAGE			MONTHLY EXTREME			Total in Inches	No. of days with Rain	Total in Inches	Mean Temp. of Water in Tank	Monthly average miles per day
	Mean	Max.	Min.	Max.	Min.						
1910	53	64	42	80	24	7	4.30	10	2.405	....	4.2
1911	54	63	45	74	27	5	11.87	16	2.882	....	4.3
1912	53	62	44	78	31	2	17.04	16	2.108	....	4.2
1913	52	60	44	79	22	4	3.74	10	1.947	....	2.1
1914	49	57	40	72	25	7	3.68	12	2.411	....	3.9
1915	54	66	43	75	27	6	5.44	15	2.019	....	3.8
1916	57	70	43	84	21	10	5.85	10	2.403	....	4.4
1917	49	61	38	80	17	11	1.53	11	2.306	....	4.4
1918	56	66	45	80	27	5	4.48	11	2.198	....	1.9
1919	55	67	44	81	27	5	1.26	10	2.098	....	3.5
1920	51	62	40	72	28	6	9.18	9	2.666	53	4.0
1921	59	71	46	82	31	2	5.40	8	2.326	64	2.7
1922	62	72	51	83	33	0	9.60	13	2.875	63	3.3
1923	60	67	53	77	32	1	8.97	17	1.690	62	4.0
1924	55	64	44	82	26	6	4.94	16	2.455	67	5.1
1925	51	59	38	81	21	7	3.16	12	2.486	53	3.6
1926	59	70	48	81	29	2	4.11	13	2.671	62	3.1
1927	52	61	43	79	26	7	7.86	15	3.121	55	3.5
1928	51	63	39	81	24	7	3.89	11	2.134	56	2.6
1929	52	61	42	75	20	10	5.67	11	1.999	59	3.4
1930	50	59	41	73	28	4	3.51	11	1.799	55	3.2
1931	59	67	52	80	41	0	10.42	16	3.077	63	4.7
1932	52	59	44	76	25	4	6.15	17	2.778	57	4.9
1933	64	75	52	84	34	0	6.62	10	2.448	66	3.6
1934	54	63	43	79	23	6	3.48	12	2.067	58	3.2
1935	49	59	39	75	27	9	7.14	8	2.757	54	2.9
1936	54	63	45	78	31	4	3.82	9	2.009	56	3.6
1937	53	61	44	73	26	6	3.43	11	1.832	55	3.9
1938	53	63	42	76	29	4	2.84	9	2.486	58	3.9
1939	56	66	45	78	30	2	3.80	9	2.607	59	3.4
1940	57	65	49	79	37	0	8.18	16	2.168	59	4.2
1941	55	65	45	78	31	2	2.04	6	2.072	60	2.7
1942	54	65	43	80	33	0	7.69	11	2.532	60	4.0
TOTAL	1794	2116	1456	2585	913	151	191.09	391	77.832	1354	120.2
Ave...	54	64	44	78	28	5	5.79	12	2.359	59	3.6

TABLE 13. MONTHLY PRECIPITATION FOR THE YEARS 1910-1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LA. (DATA IN INCHES)

YEAR	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL
1910*	4.04	3.05	1.26	1.59	7.61	8.18	9.76	3.60	3.83	1.90	2.42	4.30	51.54
1911	3.50	1.21	2.53	5.99	1.55	4.81	12.39	7.63	1.89	5.07	3.76	11.87	62.20
1912	6.99	4.64	4.24	4.50	4.03	5.99	6.68	5.59	1.63	1.55	.79	17.04	63.67
1913	5.63	2.78	2.60	4.66	4.01	3.47	4.67	8.55	13.67	5.49	2.09	3.74	61.36
1914	.96	5.01	7.13	5.59	2.28	2.48	7.28	3.48	1.78	3.09	6.92	3.68	49.68
1915	6.62	7.33	2.43	.28	4.51	3.49	5.38	11.07	1.14	2.64	2.15	5.44	52.48
1916	6.68	1.66	.34	2.46	4.90	1.93	7.70	9.82	2.69	1.81	.36	5.85	46.20
1917	4.05	3.52	3.67	2.53	1.38	5.63	8.85	2.51	2.29	.69	1.09	1.53	37.74
1918	6.10	2.95	3.44	7.91	1.50	3.98	4.74	6.01	3.75	10.36	6.64	4.48	61.86
1919	6.36	6.39	1.39	4.90	8.02	4.01	6.08	6.46	3.87	11.39	4.88	1.26	65.01
1920	6.97	5.37	1.62	3.28	4.43	4.52	10.56	9.10	3.66	5.17	4.15	9.18	68.01
1921	2.79	2.25	3.63	4.49	1.77	6.69	4.26	3.04	1.71	2.93	3.73	5.40	42.69
1922	6.38	5.17	6.31	1.58	5.59	3.86	4.62	6.29	7.28	2.98	10.23	9.60	69.89
1923	5.19	4.88	7.94	5.40	7.93	7.05	3.50	3.83	7.77	2.69	6.37	8.97	71.52
1924	6.72	3.95	2.29	2.74	1.40	1.76	1.42	1.80	1.42	0.00	2.14	4.94	30.58
1925	5.01	1.77	3.52	2.51	1.51	5.10	2.39	5.62	7.58	8.44	3.36	3.16	49.97
1926	7.47	2.83	11.51	7.68	5.73	3.20	3.68	5.72	1.91	4.98	4.86	4.11	63.68
1927	1.18	7.44	5.20	1.86	14.37	5.71	11.46	3.73	2.73	1.92	3.95	7.86	67.41
1928	.94	5.14	3.88	6.65	1.06	5.39	3.49	2.75	4.19	2.70	3.13	3.89	43.21
1929	5.50	5.47	5.67	1.80	13.35	3.53	3.70	2.87	2.40	3.28	14.92	5.67	68.16
1930	9.66	5.24	2.26	1.32	4.56	.63	4.47	5.33	10.84	3.06	4.33	3.51	55.21
1931	8.44	3.28	3.29	.97	3.01	1.77	4.63	5.29	1.59	1.62	4.78	10.42	49.09
1932	9.58	5.05	1.74	2.85	6.33	6.74	3.62	6.55	3.92	5.45	5.38	6.15	63.36
1933	3.57	3.90	6.93	4.26	5.51	5.79	11.50	2.72	2.52	1.92	1.56	6.62	56.80
1934	7.72	3.76	5.72	3.28	8.33	4.89	7.83	4.97	3.76	.77	8.61	3.48	63.12
1935	2.40	5.28	4.32	3.79	7.25	3.37	4.95	7.16	5.40	.77	3.43	7.14	55.26
1936	2.95	4.11	1.21	3.91	6.87	.13	6.57	3.62	1.72	1.57	5.06	3.82	41.54
1937	9.73	1.68	3.50	1.50	2.89	2.27	5.37	4.17	2.12	4.62	1.36	3.43	42.64
1938	4.68	2.65	1.04	4.06	1.43	5.17	7.82	6.27	7.80	.67	4.49	2.84	48.92
1939	2.92	2.51	1.84	2.83	3.38	3.94	5.66	7.29	5.25	2.30	2.12	3.80	43.84
1940	2.29	7.00	5.38	7.88	1.09	12.56	5.70	37.46	3.69	.16	15.25	8.18	106.64
1941	4.97	2.62	8.24	4.64	13.75	7.27	7.76	3.61	10.04	6.15	2.38	2.04	73.47
1942	4.90	4.57	4.93	7.87	1.34	17.23	5.27	4.76	4.81	3.82	0.24	7.69	67.43
TOTAL........	172.89	134.46	131.00	127.56	162.67	162.54	203.76	208.67	140.65	111.96	146.93	191.09	1894.18
33-yr. Ave.....	5.24	4.07	3.97	3.87	4.93	4.93	6.17	6.32	4.26	3.39	4.45	5.79	57.40

*January, February and March, 1910, figures taken from the Rayne, Louisiana (9 miles east of this station) record through the courtesy of the United States Weather Bureau.

TABLE 14. MONTHLY EVAPORATION FOR THE YEARS 1910-1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA (DATA IN INCHES)

YEAR	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL
1910*	1.745	2.685	3.269	5.656	5.862	5.772	5.544	5.394	4.580	4.306	2.668	2.405	49.886
1911	1.406	2.892	3.951	5.824	5.310	6.887	5.552	5.417	4.139	4.388	3.102	2.882	51.750
1912	1.966	2.994	3.305	4.030	5.694	5.925	5.080	5.750	4.170	4.004	2.458	2.108	47.484
1913	1.551	2.603	3.010	5.065	5.973	5.716	5.424	5.344	3.777	4.093	2.249	1.947	46.752
1914	2.053	2.246	2.815	3.981	5.237	6.835	6.123	4.420	5.145	3.506	2.168	2.411	46.940
1915	1.306	2.425	3.489	4.668	5.953	5.839	6.609	5.972	4.876	3.883	3.240	2.019	50.000
1916	2.018	2.695	4.297	4.755	5.784	6.304	5.733	5.208	5.092	5.220	2.999	2.403	52.508
1917	1.662	2.560	3.893	4.919	6.533	7.651	6.022	5.647	4.835	4.516	2.480	2.306	53.024
1918	2.193	2.201	4.146	4.180	6.136	6.695	6.791	5.709	5.276	3.794	2.980	2.198	52.299
1919	1.483	2.552	3.293	4.827	5.423	4.587	5.245	5.409	5.105	3.754	2.932	2.098	46.708
1920	0.964	2.226	2.959	3.174	5.052	4.946	4.388	5.522	5.253	3.097	2.252	2.666	42.499
1921	2.116	2.966	3.927	4.939	6.766	5.714	4.946	6.501	4.110	3.371	2.037	2.326	49.719
1922	2.598	2.351	3.726	4.838	5.911	5.305	5.610	5.832	4.652	4.649	2.963	2.875	51.310
1923	2.133	1.867	3.723	3.284	5.502	5.290	4.897	5.345	4.369	4.328	2.581	1.690	45.009
1924	1.993	2.654	3.154	4.299	4.023	6.141	5.711	5.869	6.961	5.860	3.345	2.455	53.465
1925	3.183	3.003	4.593	4.961	5.839	6.260	5.568	6.713	4.011	4.572	2.456	2.486	53.645
1926	1.708	2.759	3.621	3.981	4.357	6.373	5.531	4.958	5.238	3.643	3.286	2.671	48.126
1927	2.325	2.535	3.792	4.238	4.791	5.291	3.937	4.961	4.676	4.042	2.588	3.121	46.297
1928	2.137	2.961	3.284	4.852	6.131	5.827	5.056	5.378	4.683	4.482	2.770	2.134	49.695
1929	2.227	2.115	3.464	5.036	5.612	5.894	5.530	6.297	5.443	4.725	2.943	1.999	51.285
1930	2.052	2.413	3.396	4.487	5.298	7.375	5.662	6.285	4.212	3.738	1.970	1.799	48.687
1931	2.108	2.539	3.860	3.322	6.774	5.882	6.550	5.044	5.760	4.546	2.844	3.077	52.306
1932	2.620	2.376	4.008	5.504	5.433	6.866	5.175	5.673	4.803	4.225	2.784	2.778	52.245
1933	2.546	2.082	4.021	5.234	6.518	7.699	5.176	5.059	5.424	5.159	3.069	2.448	54.435
1934	2.263	3.009	3.968	4.974	5.921	6.879	6.134	5.578	5.251	4.361	3.583	2.067	53.988
1935	2.464	3.092	3.813	5.064	5.624	5.750	6.031	5.860	4.842	4.406	3.463	2.757	53.166
1936	2.055	2.464	3.442	5.146	5.830	7.317	6.750	5.700	5.252	4.734	4.412	2.009	55.111
1937	2.159	2.804	3.279	5.082	6.655	5.962	6.288	5.916	5.645	4.392	3.258	1.832	53.272
1938	4.102	2.625	3.601	5.002	6.568	6.128	6.606	5.540	5.440	4.572	3.366	2.486	56.036
1939	2.561	2.912	4.475	5.771	5.843	5.549	6.298	5.925	5.804	4.803	2.964	2.607	55.512
1940	2.483	2.276	4.160	4.490	5.715	5.617	5.636	5.645	6.518	4.302	3.428	2.168	52.438
1941	2.630	2.518	3.426	5.200	6.009	4.936	5.641	6.478	4.693	4.024	2.966	2.072	50.593
1942	2.554	2.531	3.409	4.643	5.691	5.647	5.334	6.058	5.767	4.731	3.510	2.532	52.407
TOTAL........	71.364	84.931	120.569	155.426	189.768	200.859	186.578	186.407	165.802	142.226	96.114	77.832	1678.876
33-yr. Ave.....	2.163	2.574	3.654	4.710	5.751	6.087	5.654	5.649	5.024	4.310	2.913	2.359	50.875

*January, February and March, 1910 figures, average of several succeeding years.

TABLE 15. Thirty-Three Year Average Weather Readings for the Period 1910 to 1942, Inclusive, at the Rice Experiment Station, Crowley, Louisiana

Month	Air Temperature, Degrees F.					No. of days with Ice	Precipitation		Evaporation		Wind Velocity
	Mean	Max.	Min.	Monthly Extreme			Inches	No. of days with Rain	Inches	Mean Temp. of Water in Tank*	Miles per day
				Max.	Min.						
Jan...	54	63	44	77	26	5	5.23	11	2.176	57	4.1
Feb...	56	66	46	78†	29†	3†	4.07	10	2.574	60	4.5
March	61	70	50	82	34	1	3.97	9	3.654	65	4.8
April..	68	78	57	86	40	0.03	3.87	8	4.710	72	4.5
May..	75	84	64	91	52	0	4.93	8	5.751	80	3.5
June..	81	89	72	95	64	0	4.93	11	6.087	85	2.6
July..	82	90	74	96	69	0	6.17	13	5.654	88	2.0
Aug...	82	91	73	96	67	0	6.32	13	5.649	88	1.9
Sept..	78	88	68	94	56	0	4.26	10	5.024	84	2.1
Oct...	70	81	58	90	40	0.27	3.39	8	4.310	75	2.4
Nov..	60	71	48	84	30	2	4.45	8	2.913	64	3.0
Dec...	54	64	44	78	28	5	5.79	12	2.359	59	3.6
Annual..........							57.38		50.891		

*23-Year average.
†31-Year average.

TABLE 16. The Highest Temperature and the Lowest Temperature (Degrees F.) Each Year; the Monthly and Annual Extreme Precipitation, and the Dates on Which They Occurred; for the 33-Year Period from 1910 to 1942, Inclusive, at the Rice Experiment Station, Crowley, Louisiana

TEMPERATURES

Year	Highest		Lowest	
	Degrees	Date	Degrees	Date
1910	94	August 2, 3, 23	24	December 7
1911	101.5	June 13	22	November 30
1912	96.5	September 6, July 31	18.5	January 13
1913	99	July 9	28	January 8
1914	100.5	June 30	26	December 14, 15
1915	98	June 22, 23	27	December 3, January 25
1916	96	June 26	21	December 12
1917	97	June 30	17	December 30, 31
1918	100	June 18	9	January 12
1919	97	August 8	22	January 4
1920	95	June 28	27	November 17
1921	98	July 6, August 22	31	December 5
1922	101	August 2	30	February 8, March 4
1923	95	July 24	27	March 20
1924	101	August 25	18	January 6
1925	100	August 20	21	December 28
1926	99	July 3	29	December 16, January 13, 14
1927	97	August 17, September 18	25	January 11
1928	97	August 9, 10	19	January 2
1929	95	June 21	20	December 23
1930	103	June 27	19	January 18
1931	97	July 2	30	January 21
1932	98	July 15, 16, 17	25	December 17
1933	97	June 20	19	February 9
1934	100	July 23	23	December 12
1935	103	August 10	20	January 22, 23
1936	98	June 21	25	January 31
1937	96	June 22	28	February 11, March 1
1938	96	July 5, August 26	23	November 28
1939	97	July 7	28	February 23
1940	94	July 28, September 1, 5, 8, 9, 10.	16	January 19, 20
1941	96	August 19, 24	27	January 19
1942	95	July 14, 15, August 1	22	January 8

PRECIPITATION

Month	Highest		Lowest	
	Inches	Year	Inches	Year
January	9.73	1937	.94	1928
February	7.44	1927	1.21	1911
March	11.51	1926	.34	1916
April	7.91	1918	.28	1915
May	14.37	1927	1.06	1928
June	17.23	1942	.13	1936
July	12.39	1911	1.42	1924
August	37.46	1940	1.80	1924
September	13.67	1913	1.14	1915
October	11.39	1919	0.00	1924
November	15.25	1940	.24	1942
December	17.04	1912	1.26	1919
Annual	106.64	1940	30.58	1924

TABLE 17. DATES OF LAST ICE IN SPRING, FIRST ICE IN FALL, AND SNOW, SLEET AND FROZEN RAIN WITH ACCOMPANYING AIR TEMPERATURES FOR THE 33-YEAR PERIOD 1910 TO 1942, INCLUSIVE, AT THE RICE EXPERIMENT STATION, CROWLEY, LA.

YEAR	LAST ICE IN SPRING		FIRST ICE IN FALL		SNOW, SLEET AND FROZEN RAIN
	Date	Temperatures Degrees	Date	Temperatures Degrees	
1910	April 25	33*	October 29	30	
1911	February 25	31	November 27	27	
1912	February 22	29	November 4	28	March 1, few flakes of snow.
1913	February 25	30	December 9	28	
1914	March 23	32	November 20	32	February 24, 2 inches of snow, some sleet and frozen rain.
1915	April 5	32	November 16	30	
1916	March 4	30	November 15	28	
1917	March 5	28	October 20	32	
1918	February 5	32	December 2	32	January 11, $^3/_4$ of an inch of snow. December 20 and 21, frozen rain. Objects coated with thick ice, much destruction to shrubbery.
1919	January 13	32	December 10	32	
1920	March 7	32	October 28	28	
1921	None	..	December 5	31	
1922	March 4	30	None	..	
1923	March 20	27	December 15	32	
1924	March 16	32	November 25	29	
1925	February 12	30	November 23	30	
1926	February 20	32	November 19	30	January 23 and 24, a little snow, sleet and frozen rain.
1927	January 16	26	December 4	32	
1928	February 19	31	November 21	29	January 22, a little snow.
1929	March 2	31	November 30	28	December 21, sleet and frozen rain coated objects with ice to a thickness of one inch, causing great damage to trees, shrubbery and telephone poles.

TABLE 17 (Continued)

Year	Last ice in spring		First ice in fall		Snow, Sleet and Frozen Rain
	Date	Temperatures Degrees	Date	Temperatures Degrees	
1930	March 4	30	November 25	31	
1931	January 14	32	None	..	
1932	March 13	28	November 12	30	March 11, a little snow and sleet.
1933	February 12	27	None	..	
1934	March 19	32	December 8	31	
1935	February 28	27	November 23	32	January 22 and 23, two inches of fine, dry snow. December 21, a little snow and sleet.
1936	February 20	29	November 16	32	
1937	March 2	32	November 18	30	March 28, a little sleet.
1938	February 2	31	November 9	30	
1939	February 23	28	November 5	30	
1940	February 22	31	November 14	32	January 19-23, inclusive, sleet, snow, and frozen rain, ground covered to a depth of $1\frac{1}{4}$ inches which remained in sheltered places until February 3.
1941	February 9	30	November 26	31	
1942	February 22	32	November 24	31	February 20, a little sleet.

*Unusually low for this time of the year.

LOUISIANA BULLETIN NO. 377 JULY, 1944

FOREST LAND OWNERSHIP IN LOUISIANA AND ITS INFLUENCE ON TIMBER PRODUCTION

By

A. D. FOLWEILER
ASSOCIATE FORESTER
LOUISIANA AGRICULTURAL EXPERIMENT STATION

December, 1943

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS
W. G. TAGGART, *Director*

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FOREST LAND OWNERSHIP IN LOUISIANA AND ITS INFLUENCE ON TIMBER PRODUCTION

By

A. D. FOLWEILER

INTRODUCTION

A Digest of the Findings

The State and the Federal governments have attempted to deal with the task of increasing the fund of timber. Progress has been made through public aid to private landowners and by public acquisition of forest land in fee. The results to date, however, have not been as widespread or as productive as might be expected. This can be attributed, for the most part, to an adherence to the basic policy of the State expressed in the Forest Conservation Act.

The Act was founded on the priciple of aiding private landowners in protecting their lands against forest fires. But protection against fires in only a start toward increasing the fund of timber. Provision for future stands of timber through leaving a sufficient supply of seed trees at time of cutting, or planting where none are available, must be given as much emphasis as protection against fires. The proposals made in this paper have taken into consideration the important factors of natural and institutional characteristics in each important forest type. Particular attention has been given to the privately owned forest land.

Title to the forest land of Louisiana is held mostly by private owners. The public owns approximately twelve percent. Of this, more than half is in the dubious category of tax-adjudicated land to which the State has only a tenuous title. The Federal government holds title to approximately one-third of the above-mentioned twelve percent. This means, therefore, that the task of increasing the fund of timber in Louisiana, available for use by the forest products industries, is intimately bound up with private ownership. The number of private holdings is very large. These owners, moreover, are a heterogeneous lot from the standpoint of purpose in retaining title to their forest land holdings.

Louisiana contains forest land that can be grouped into three important forest types. These types are (a) the loblolly-shortleaf of Northwest Louisiana, (b) the longleaf-slash type of the Southwest and the Southeast, and (c) the Mississippi bottomland hardwoods.

In the loblolly-shortleaf area, there are approximately three thousand feet board measure of sawlogs, or thirteen cords of pulpwood on the average acre. In contrast to this, in the longleaf-slash type, there are one thousand feet board measure of sawlogs, or three cords of pulpwood. This condition is the result of the ability, or lack of it, of each forest type to establish young stands of timber. In turn, this is reflected in the ownership of the land. In the loblolly-shortleaf type, 40 percent of the forest land is owned by forest products industries that operate manufacturing units dependent upon the timber on their own and adjacent lands. Farmers, or private owners who hold title to farm units, account for 39 percent of the forest land ownership. Miscellaneous people, i.e., the operator of a dry-goods store in the county seat, a local lawyer, a nearby school teacher, and others who hold title to forest land detached from either a farm or industrial unit, hold title to only 21 percent. In the longleaf-slash type, on the other hand, the owners of farm units hold title to only 11 percent of the forest land. The forest products industries own 25 percent, and the miscellaneous owners, which include the forest products industries that have liquidated their timber holdings and dismantled their mills, hold title to the remaining 64 percent, or almost two-thirds of all the forest land.

Insofar as the pine types of the State are concerned, the forest products industries have much more incentive to hold forest land in the loblolly-shortleaf type than in the longleaf-slash. The first-mentioned type is much more readily managed for continuous timber production than the latter.

In the Mississippi bottomland hardwood type, even in the most productive area, viz., the Delta or Northeast Louisiana, the fund of timber is only three thousand feet board measure of sawlogs on the average acre, or eleven cords of pulpwood. Of the pulpwood, less than half of the volume is currently utilizable by pulp mills because of the pulping characteristics of some of the species. In the Delta area, the forest products industries own only about one-quarter of the forest land. Almost half of the forest land is attached to agricultural units. Miscellaneous owners hold title to the remaining one-quarter of the forest land area.

In the nine parishes that were studied intensively for ownership, there were almost 16,000 owners who held title to slightly more than 3,000,000 acres of forest land. For a given unit of forest land, owners are most abundant in the loblolly-shortleaf type and least numerous in the bottomland hardwood area. The average area held per owner in the loblolly-shortleaf type is 150 acres, in the longleaf-slash 213, and in the bottomland hardwood 630. These data lead to the conclusion that the task of increasing Louisiana's fund of timber is one of dealing with the reconciling the divergent points of view of numerous individual owners. Due to the complex pattern of ownership caused by the numerous title-holders, there is no simple and single approach to the task of increasing the fund of timber. The job is further complicated by the heterogeneous nature of the forests. Each forest type needs to be treated as an entity.

Because of the relative ease with which forestry can be practiced in the loblolly-shortleaf area, which is about twice the size of the longleaf-slash type, most attention has been devoted to it in this inquiry. In 1943, the forest land of the loblolly-shortleaf area was producing at less than half of its capacity. This situation prevails in the type in which, as just mentioned, forestry can readily be practiced. But the ownership pattern is complicated. Farm units, with their ancillary forest land, intermingle with industrial and miscellaneous holdings. Most forest products industries wish to keep their lands productive but, having no control over adjacent privately owned lands, have no incentive to practice forestry on other than their own holdings. The State, however, has the social responsibility for doing those things that will maintain the productivity of the forest land insofar as it is able under our prevailing institutions. The State can redeem its social responsibility by reconciling the divergent views of the forest land owners. A plan for achieving this is offered in the Forest Conservation Districts, comparable in operation to the Soil Conservation Districts. The District plan recognizes the community-of-interests of all classes of forest land owners. The plan offered in detail in this publication is based on the State making it possible and desirable for all classes of landowners to work together so that forestry can be practiced on a more widespread basis than is today possible.

The practice of forestry in the longleaf-slash type is more difficult than in the loblolly-shortleaf. This is caused by the characteristics of the species. The ownership pattern that currently exists is, in part, a reflection of the peculiarities of the forest type. Cutover forest land reseeds reluctantly. The land, moreover, is not well suited to farming so there are fewer farms per unit of land area than are found in the loblolly-shortleaf type. Within recent years, moreover, several oil fields have been developed within the area covered by the type. The State's laws pertaining to sub-surface values encourage continued fee ownership, even though the surface has been denuded of its forest cover and in spite of the land's unsuitability for farming. Because of the long-time nature of the enterprise, the owners have very little incentive to invest money in timber production. If the area covered by the longleaf-slash type is again to become highly productive of timber, there must be planting of tree seedlings done on an extensive basis. This will call for an investment of capital on more than a million acres. Recognizing that it is doubtful that the laws pertaining to sub-surface values will change soon, and keeping in mind the difficulty of interesting the landowners in forestry because of the denuded condition of so much of the area, a lease arrangement between the State and private owners appears to be a practicable solution. There is a discussion in detail below as to reasons why the State would be justified in leasing the surface from the present owners who retain title primarily, and frequently only, because of sub-surface values.

Just as Louisiana has had some of the finest stands of longleaf pine in the South, so has it had high-quality forests of hardwood timber, particularly red gum and cypress. The hardwood forests, however, have been well culled over. The quality of the timber now present is considerably inferior to what once existed. Very little is known, moreover, of the silviculture of bottomland hardwoods. The nub of the task of increasing the fund of timber in the hardwood belt is the utilization of the low-grade species and low-value trees that dominate so much of the area. The bottomland hardwood type accounts for almost half of the forest area of the State, but very little is known of forest management for it. Much needs to be done to determine economic uses of the low value species that occupy so much of the bottomland hardwood area.

—A. D. FOLWEILER.

I

PURPOSE OF STUDY

This study is devoted to an examination of forest land ownership in the State. Ownership and management are intimately associated. The ownership of private property gives to the owner the exclusive right to economic goods. Inasmuch as forest land is a form of private property, the owner has the right to produce, or refrain from producing timber. If it is desirable for Louisiana to produce more timber to serve as raw material for manufacturing plants, it is first necessary to know who owns the land that is commonly referred to as forest land.

For the last three decades the production of lumber has decreased because of lessening supplies of timber of sawlog size. Within the recent two decades, pulp manufacturing, a heavy chemical industry utilizing timber as raw material, has to some extent offset the decrease in manufacturing employment caused by the decline of the lumber industry. Other manufacturing in Louisiana, based largely on the use of petroleum, salt, sulfur, and gas, all raw materials obtained below the land surface, has increased in importance. Of the State's important natural resources, however, timber is distinctive in that it is renewable. With the practice of forest conservation, Louisiana's forest land can make very important contributions to the State's economy.

Sawmilling in the State was once characterized by manufacturing units of high productive capacity requiring large-sized and extensive stands of timber for efficient and profitable conversion into boards and structural timbers. The trend of the sawmill units today, however, is toward smaller plants that no longer rely on large-sized virgin timber. The modern transportation system, i.e., good roads and trucks, makes it possible for modern sawmills to operate without the construction of railroads devoted exclusively to the movement of logs. The virgin stands of timber have been succeeded by smaller-sized second-growth or "junior" forests. The sawmill industry has adjusted itself to the change in size of timber. Today relatively small units with an annual capacity of 25 to 50 million feet board measure have, for the most part, taken the place of the large mills, with annual production of around 200 million feet. The smaller timber has also attracted pulp mills that prefer this sort of timber. With a shift in the type of manufacturing plants that utilize timber, there has undoubtedly been a change in forest land ownership. The sawmills at one time were in the enviable position of owning or controlling most of the timber needed for their manufacturing plants. When a large mill had liquidated its resources, it dismantled its mill and sold its cutover land when it could. The land had been acquired not because of a desire to own land, but because of the timber that was on it. Once the timber was removed, the land was regarded as a residue, and frequently, a liability.

The degree to which forest products industries can contribute to the economy of the State, i.e., by employing people, is determined by the fund of timber. If the forest land is maintained at a high level of its potential productivity, more forest products industries can be sustained than if the fund is low. But, as mentioned above, the productivity of the land is dependent upon the attitude of the owners. For this reason it is worth while to examine the relationship of forest land ownership and the productivity of the land.

THE FORESTS AND FOREST LAND AREA

The area of the State is 29,061,700 acres.[1] According to a recent United States Forest Service publication,[2] the forest land area is 16,193,000 acres, or approximately 55 per cent of the State's total area. Actually the percentage of forest land is probably slightly in excess of 55 percent, for in the statistic no deductions were made for areas covered by water.

Of the land area in forests, 11.9 percent is in public ownership and 88.1 percent in private ownership. Louisiana is typical of the southern states, in contrast to many western states with regard to the relationship between private and public forest land area. In the South forest land is owned predominantly by private rather than public owners.

MAJOR ASSOCIATIONS OF FOREST TREE SPECIES

Subject to certain qualifications, it can be stated that approximately one-half of Louisiana's forest land is covered by hardwood timber, including cypress, and the other half by pine. Among the southern states, Louisiana is unique in having so large a percentage of its forest land in the bottomland hardwood category. In Georgia,[3] for example, only four percent of the forest land is classified as bottomland hardwood in contrast to Louisiana's 47 percent. This is due to the presence of the nation's largest watercourse, the Mississippi River, and its peculiar behavior in emptying its load into the Gulf of Mexico. Especially before the levee system was established, annually a great deal of land was inundated and enormous deposits of silt were laid down as the water receded into the stream channel. The effect of this was to drive the pine species to the rolling uplands, leaving in the overflow areas the more flood-resistant hardwood species. The fine-textured soil deposited by the frequent inundations created an environment unsuited to pine timber.

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[1] State of Louisiana, Dept. of Commerce and Industry; *Louisiana's Resources and Purchasing Power,* 1938.

[2] United States Department of Agriculture, Forest Service Miscellaneous Publication No. 519, *Louisiana Forest Resources and Industries,* 1943.

[3] United States Department of Agriculture, Forest Service, Miscellaneous Publication No. 501, *Georgia Forest Resources and Industries,* 1943.

The fact-finding Forest Survey recently released data[4] which show that in Louisiana the distribution of forest land, classified by the four major forest types, is as follows: bottomland hardwoods 47 percent, loblolly-shortleaf pine 31 percent, longleaf-slash 16 percent, upland hardwoods 6 percent. For the purpose of simplification in the discussions in this paper, only three of the major types will be used. The upland hardwood area, because of its limited size, will be omitted.

Reference to the major types can hardly be made without some mention of forest capital. The Forest Survey data[5] show that Louisiana had 42.4 billion feet, board measure, of timber in 1938. Of this amount, 64 percent was in hardwoods and 36 percent in pine. In 1937 there was a net increment of 1.9 billion board feet and a commodity drain of 2.3 billion board feet, or a deficiency of 0.4 billion feet, board measure. Expressed in units of cords for the forest capital five inches and larger in diameter, there was a net growth of 7 million cords and a commodity drain of 6.3 million cords, or a surplus of 0.7 million cords of wood, not all of which was commercially desirable.

If the data just mentioned above is to have any direct connection with this study, it should be divided into major forest types. Of the two pine types, the loblolly-shortleaf type is not only almost twice as large in land area as the longleaf-slash, but also has a greater per acre volume of timber. Although the sawlog volume is only 3.0 thousand feet board measure per acre in the loblolly-shortleaf type, it is three times as great as that found in the longleaf-slash type. If the forest capital is expressed in cordwood units, there is an average of 12.8 cords of timber per acre in loblolly-shortleaf type, or a little over four times as much as is found in the longleaf-slash area where the average is 3 cords per acre. These statements do not imply that the productive *capacity* of the two areas bears the relationship indicated. The data merely show that at the time the forest survey was made, there was much more timber on the loblolly-shortleaf lands than on the longleaf-slash. Neither forest type, particularly the longleaf-slash, is attaining nearly its productive capacity. For this reason, it can be stated that Louisiana is wasting one of its important resources.

In the bottomland hardwoods of the Mississippi overflow areas, the average forest capital, per acre basis, is 2.78 thousand feet board measure.

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[4] United States Department of Agriculture, Forest Service, Miscellaneous Publication No. 519, *op. cit.*

[5] *Ibid.*

Most of this volume is in species that are in very low commercial demand. The data of the Forest Survey show that only 18 percent of the forest land area in the upper part of the bottomland hardwood or Delta territory has 1000 or more board feet of timber utilizable for lumber, veneer, and cooperage manufacture. In the southern part of the overflow area, 20 percent of the forest land has utilizable species of more than 100 feet board measure. Expressed in cubic measure, there are 10.6 cords per acre of timber on the hardwood bottomlands, but only half of this is in soft-textured species used by the pulp industry.

From the standpoint of economic considerations, the above facts lead to the conclusion that the loblolly-shortleaf forest type is the most important in the state. In spite of the fact that it has been subjected to almost the same cutting conditions and frequency of fires as has the longleaf-slash, the silvicultural characteristics are such that today it has much more forest capital on it, on a per acre basis, than has the longleaf-slash area, and is almost twice as large in size. Although the area of the state in bottomland hardwoods amounts to more than half the forest area, most of its forest capital is such that it is not readily utilizable by sawmills, pulp mills, veneer factories, or cooperage plants. In spite of the pine area of the State being slightly less than half of the total forest land, and furthermore being fairly well depleted of its forest capital, it still produces twice as much lumber as the bottomland hardwood area.

PUBLIC OWNERSHIP AND CONTROL OF FOREST LAND

Public holdings can be grouped under three broad headings, viz., federal, state, and municipal. Ownership of public forest lands, in 1942, is shown in the data in Table 1. The categories in Table 1 are by no means exhaustive. There has been some public acquisition of forest land

TABLE 1

PUBLIC OWNERSHIP OF FOREST LAND, 1942

AGENCY	Area in acres
Federal	
Forest Service	505,000
Soil Conservation Service	31,000
Farm Security Administration	51,000
Wartime holdings for ordnance plants and military bases	20,100
Mississippi River Commission	50,000
State	
Department of Conservation, Division of Forestry	12,800
State Park Commission	8,800
Land Office—Free land	20,000
Tax adjudicated	1,150,000
Parish School Boards	75,784
TOTAL	1,924,484

because of the war effort, but the amount has been limited. The war effort acquisitions are not included. The data do show, however, that forest land in Louisiana is owned predominantly by private owners rather than the public which owns or controls the surface rights to 11 percent of the forest land.

FEDERAL HOLDINGS

The Federal holdings in fee of forest lands in Louisiana are administered by three U. S. Department of Agriculture bureaus, namely, the Forest Service, the Farm Security Administration, and the Soil Conservation Service.

The public agency controlling the largest acreage of forest land is a comparative newcomer to the State. Acquisition of forest land for national forest purposes in Louisiana required under authority of the Weeks Law of 1911 did not commence until 1932. The focal point of the national forest holdings is the city of Alexandria in Rapides Parish, but national forest lands are situated in eight of the State's 46 wooded parishes.

The Forest Service administers 505,000 acres of Federal land dedicated to national forest purposes. These lands are predominantly cutover pine and situated in the central part of the State. Acquisition of these national forest lands in Louisiana, known as the Kisatchie National Forest, commenced in 1929. By the time the Civilian Conservation Corps struck its stride in 1934, these lands were available to receive the improvements that could be made by the CCC labor. A great deal of the forest area contained in the Kisatchie was in need of planting and could be rehabilitated only through planting. This was done, as well as many other necessary forestry jobs, by the Civilian Conservation Corps. The Forest Service has consistently distinguished itself, as a Federal bureau, for the excellent management of the national forest lands, its largest administrative job. As the result of excellent forest conservation practices, the Kisatchie National Forest will some day contribute materially to the forest resources of Louisiana and at a much earlier date than if these lands had been left in private ownership. When acquired by the Federal government, they were severely depleted of forest capital. Without a heavy investment of capital funds, the forests would probably have remained in a severely depleted condition especially those lands that at one time had been covered by longleaf pine. Private ownership in Louisiana has been consistently reluctant to invest money in reforesting depleted longleaf lands. This attitude is undoubtedly justified because of the problems associated with managing longleaf pine.

The Soil Conservation Service administers 31,000 acres of land, most of which is forested, although there is some abandoned agricultural land intermingled with it. These lands lie in the northwestern part of the state where the loblolly-shortleaf forest type prevails. This acreage was inherited from the Resettlement Administration at the time that agency was liquidated. Although the Soil Conservation Service's primary job is extending educational and advisory services to private owners of agricultural units in order to conserve soil productivity, it was probably assigned the forest area it administers today because the land lay well beyond the boundaries of the purchase units established by the Forest Service for the Kisatchie National Forest. This agency now administers this land in two separate units of approximately 13,000 and 18,000 acres in Webster and Claiborne Parishes respectively. The chief land use of these areas is timber production, with cattle and agricultural commodity production as secondary uses.

The Farm Security Administration administers 51,000 acres of Federal land in the Delta hardwood area, one of the most fertile alluvial areas of the State. Of the area administered by this bureau 20,100 acres are considered as forest land. At the present time, the bureau has no long-range, well-developed policy for administering these forest lands.

Although the Mississippi River Commission holds title to very little forest land, it has effective control over the surface rights of a considerable area covered by hardwood timber in the Morganza Floodway. It has been the policy of the Commission to secure easements that allow the Federal government to use the surface for virtually any purpose, including the supervision of the pasturing of animals and reforestation of open lands. Removal of timber from the land is prohibited except under the specific permission of the Commission. This virtually gives absolute control to the Commission of 50,000 acres of hardwood forest land.

State Holdings

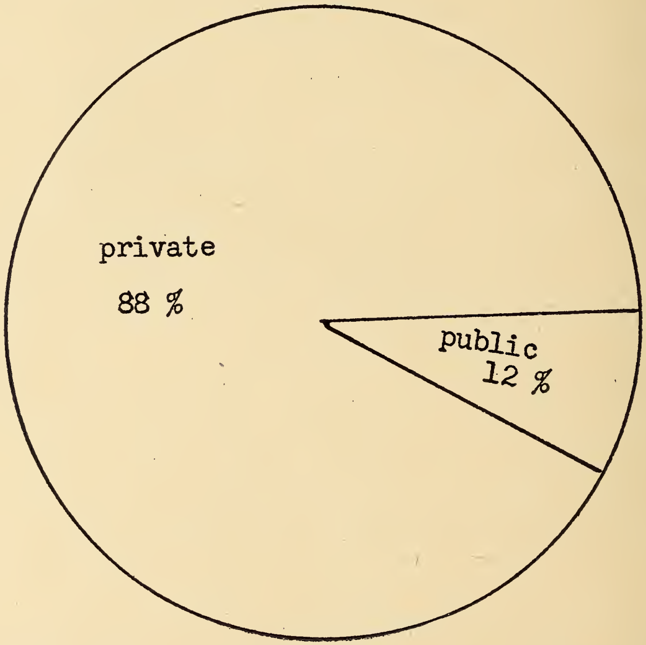
The State's holdings of forest land can be broken up into several classes, consisting of state forests, 12,800 acres, state parks, 8,800 acres, and land adjudicated to the state for non-payment of taxes, approximately 1,150,000 acres. The Division of Forestry, within the Department of Conservation, administers the two state forests. The State Park Commission administers the land dedicated to use as state parks.

Tax Adjudicated Land

One way in which a state or lesser political unit acquires title to forest land is through tax payment delinquency. Just what becomes of the title to forest land upon failure of the private owner to pay taxes varies with the political unit in which it is situated. New York, for example, created public forest reserves in the Adirondack and Catskill Mountain regions out of land that had reverted to the State because of tax delinquency.

In Louisiana in the period 1931-1934, title to an enormous amount of real property had been transferred from debtors to creditors. In many instances those creditors were banks whose title to the property they obtained through foreclosure, was clouded by liens caused by tax delinquency. The situation was further complicated by the inability of several banks to conduct business after the "bank holiday" of the early part of 1933. In order to help the process of liquidation of real property, the Legislature enacted laws that made it possible to thaw titles frozen by tax delinquency and thus lubricate the economic machinery. An important group of beneficiaries from the legislation, discussed in greater detail below, was land-owning forest products industries, particularly sawmill companies. Numerous examples of the redemption of their land titles were shown the writer in the files of the State Land Office.

The pattern for tax delinquency of land and subsequent redemption of title was established by Act 170 of the 1938 Legislature. According to this Act, taxes levied for a given calendar year became "delinquent" January 1 of the year following. On the twenty-first of January, notice of this delinquency is mailed to each owner whose land has fallen into this category. In event the taxes have not been paid by February 10, a notice is sent by registered mail to the delinquent landowner, calling his attention to the status of his land. Sometime in June, public notice is given through newspapers of the delinquent status of the lands on which tax payment is overdue and a date set for the sale of these properties. These public notices usually appear five times in local newspapers, extending over a thirty-day period. Sometime in July the sale is then held by a parish official and if the property is not purchased at that time, the



Relationship of public and private holdings of forest land title becomes vested in the State shortly thereafter when the parish tax collector supplies the State Land Office with a list of unsold tax-delinquent lands. The Act 170, 1898, further provides that once title to lands has been adjudicated to the State, in order that the original owner may redeem the land, the taxes due the State, as of the year of delinquency must be paid, plus a 20% penalty. This is paid to the State Land Office. As a prerequisite to the issuance of the State's certificate of redemption, evidence must also be furnished that the local taxes as of the year of adjudication, plus taxes assessed thereafter to the year of redemption as well as State taxes, have been paid the Tax Collector of the parish in which the lands are situated. In order to lighten the redemption load borne by the delinquent tax payer, the assessed value of the property may be lowered subsequent to the year of delinquency should the facts concerning the land warrant a reduction. The facts duly approved by the Assessor and Tax Collector of the Parish must be presented to the Louisiana Tax Commission by the tax debtor for the Commission's consideration and concurrence. Should the tax payer be unable to secure the approval of the Parish Officials, the Tax Commission is empowered to reduce the value should it deem this desirable, also requiring the Tax Collector to accept payment of any and all taxes on the revised value.

During the period 1931-1935 when large areas of land became tax delinquent, the State adopted the policy of permitting just as much real property to remain in private ownership as possible by enacting suitable legislation.

The passage of Act 161 of the 1934 Legislature permitted the redemption of property adjudicated to the State, regardless of the period of delinquency, by paying the taxes as of the year the land became delinquent, provided the payment was made between the enactment and September 30, 1935. Further aid to the private owner in the redemption of land adjudicated to the State was extended by Act 14 of the Legislature's Fourth Extra Session of 1935. This act provided that title to land that had been adjudicated to the State could be redeemed by paying only the taxes as of the year of delinquency, provided they were paid within the period September 30, 1935 to a date twenty days after the regular 1936 Session of the Legislature adjourned. In the Legislative Session of 1936, an act was passed with wording somewhat at variance with those previously enacted on the subject of restoration of title. This law was declared unconstitutional, but in the 1938 legislative session, Act 47 was passed with wording that was not contested, being almost identical with that used in the acts of 1934 and 1935.

Although the forest land adjudicated to the state amounts to approximately 1.1 million acres, and even though Craig[6] stated that, among the southern states, Louisiana ranks high in its quantity of tax delinquent lands, more forest land is not tax delinquent because owners prefer to retain title to the land for speculative reasons. In Beauregard and St. Tammany Parishes in particular, even with very low productivity from the surface of the land, tax delinquency is very low because of speculation on sub-surface values discussed under another heading.

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[6] Craig, Ronald B., *The Forest Delinquency Problem of the South;* U. S. Forest Service, Sou. For. Exp. Sta., Oc. Paper 92, 1940, mimeo.

REMNANTS OF THE ORIGINAL PUBLIC LAND

There is a very limited quantity of forest land with title vested in the State, land that has never been alienated from public ownership. These holdings are extremely scattered, made up of numerous small tracts, and in the aggregate amounting to less than 20,000 acres. Because of the scattered condition of these holdings, no attempt is made at administration. Although the State has never conveyed title to them or sold the timber on these lands, it is doubtful whether there is actually any timber on them, for lack of administration of forest land results in continuing diminution of value because of theft, fire, and other factors.

FOREST LAND OWNED BY PARISHES

Some forest land is owned at the parish level of government because of the sectional land grants made to the state for school purposes by the Federal government. These lands are nominally controlled by the parish school board. Within recent years, some of these lands have been given some forestry supervision in order that a continuous income might be derived from their management, but the lands receiving administration of this sort are very few. By Congressional Act of April 2, 1806, the sixteenth sections of townships still in the public domain were granted to some states for school purposes. One of the states that was the beneficiary of this act was Louisiana. By virtue of this Act, Louisiana was the recipient of 807,271 acres of land. These sixteenth sections could be sold, if, by referendum, the majority of people residing in the township in which they were situated agreed to it, but the principal sum derived from the sale could not be used. The State was made custodian for the principal, with the parish school board in which the township was located the recipient of interest from the principal sum. The effect of this provision was that many sixteenth sections were sold. This accounts for the fact that there is a wide discrepancy in the forest acreage held by the several parishes listed in Table 2. In the aggregate there are approximately 75,000 acres of forest land held by parish school boards, but apparently most of this land is alluvial in nature. Most of the parishes in the hill areas of the state appear to have disposed of all or part of their sixteenth sections in contrast to parishes along the western Gulf coast that have retained all their school sections.

In many cases those parishes that retained title to their sixteenth sections have been greatly aided financially since all income accruing from these lands becomes available directly to the parish school board.

If timber is cut on these unsold lands, the local school board receives the income; if the land is leased for oil drilling and petroleum is discov-

TABLE 2.

FOREST LAND OWNED BY PARISH SCHOOL BOARDS
REMNANTS OF 16TH SECTION LAND GRANTS

PARISH	Original Grant	(Acres) Current Residue of Grants 16th Sect. Lands
Allen	unknown	....
Ascension	6,400	700.00
Avoyelles	12,160	5,285.64
Beauregard	unknown	....
Bienville	12,800	....
Bossier	17,920	....
Caddo	16,000	2,000.00
Calcasieu	37,120	15,838.00
Caldwell	5,120	860.00
Catahoula	12,160	2,880.00
Claiborne	14,720	....
Concordia	10,240	3,420.48
Desoto	16,000	1,240.00
East Baton Rouge	9,880	2,136.20
East Carroll	8,320	3,155.58
East Feliciana	7,680	....
Evangeline	unknown	1,920.00
Franklin	6,400	1,188.00
Grant	5,760	670.00
Iberia	7,680	5,001.78
Iberville	10,240	....
Jackson	4,480	....
LaSalle	unknown	2,445.00
Lincoln	8,320	....
Livingston	7,040	....
Madison	12,160	760.50
Morehouse	10,240	6,472.00
Natchitoches	12,800	4,284.84
Ouachita	7,680	2,021.32
Pointe Coupee	7,040	....
Rapides	12,160	844.70
Red River	6,400	....
Richland	4,480	2,560.00
Sabine	16,000	....
St. Charles	unknown	709.56
St. Helena	unknown	....
St. Landry	15,360	994.00
St. Martin	7,040	6,853.65
St. Tammany	12,160	....
Tangipahoa	10,880	....
Tensas	13,440	....
Union	14,080	....
Vernon	10,880	....
Washington	8,320	....
Webster	12,160	....
West Baton Rouge	2,560	1,525.00
West Carroll	4,480	....
West Feliciana	8,960	....
Winn	9,600	....

ered and removed, the parish school board receives the royalties. Some parish school boards that have title to several sixteenth sections are today receiving splendid incomes.

PRIVATE FOREST LAND OWNERSHIP

It is a common practice to divide forest land owners into two broad groups, e.g., public and private. The latter group represents an extremely heterogeneous mass. To determine the distribution of private forest land owners in all the wooded parishes of the State would have been an enormous task, so a sampling procedure was used in this study. An effort was made to use at least two parishes in each of the major forest types as the means of determining ownership. Parishes were selected that are predominantly within one forest type.

TABLE 3.

PARISHES SELECTED AS REPRESENTATIVE OF FOREST TYPES IN WHICH PRIVATE OWNERSHIP OF FOREST LAND IS DOMINANT

Longleaf-Slash	Loblolly-Shortleaf	Bottomland Hardwoods
Beauregard	DeSoto	Concordia
St. Tammany	Jackson	Madison
	LaSalle	
	St. Helena	
	Union	

PARISHES SELECTED IN EACH FOREST TYPE

For purposes of forest management, the longleaf-slash forest type presents land use problems quite at variance from the others in the state. Old-growth longleaf pine stands, after cutting, restock only through a peculiar combination of circumstances infrequently prevailing.[7] The probability of the right combination of circumstances suitable to re-establishing longleaf is very low. It was one of these accidents, however, that has produced natural reproduction in localized areas and was the chief contributing factor in having the Great Southern Lumber Company, a large sawmill unit of Southeast Louisiana, undertake its reforestation work in 1924 in order to stay in business as a pulp company after the stands of old-growth longleaf pine timber had been exploited for sawlog purposes.

The two parishes belonging to the longleaf-slash type were selected for some other reasons in addition to their forest cover. Beauregard parish was chosen because there is no public ownership of forest land, it lies wholly within the longleaf-slash forest type, its soil is poorly suited for agricultural development, and the area has obviously been heavily exploited by wood-using industries. Moreover, only two small oil fields are situated in the parish, and it lies on the west side of the Mississippi River. Beauregard Parish is included in Forest Survey Unit No. 3. It is a forest area which presents land problems that are the result of over-exploitation of forest resources. It was originally covered almost entirely with longleaf pine. The report on Survey Unit No. 3[8] calls attention to the great waste of forest land. Almost one-quarter of the forest land has been clearcut so that it is not reproducing. On this clearcut area, the average stand of sawtimber per acre is 40 board feet, very much in contrast with uncut longleaf stands that at the time of the Survey supported stands of almost 17,000 feet board measure. The second-growth stands of the area are very badly understocked; this fact, coupled with the constant tendency to cut timber too quickly, before it has had an opportunity to put on good volume increment, explains why the average second-growth longleaf has a volume of only 2,300 feet per acre. In its report on this Unit, the Forest Service states, "The most striking and serious defect in the forests of Southwest Louisiana is the appalling acreage of denuded lands . . . 54 percent of the longleaf land is in this unproductive condition."[9]

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[7] The primary requirements are abundant seed supply, but seed years occur only at seven-year intervals; a mineral seedbed created by fire or logging; and freedom from wild (uncontrolled) fire for two years after establishment.

The longleaf-slash forest type straddles the Mississippi River. Beauregard Parish, described above, was selected as representative of the type west of the River. Mention should be made that slash pine (Pinus caribaea) occurs naturally only east of the Mississippi River in the three easternmost parishes, St. Tammany being one. This means, therefore, that the natural obstacles to forest management in St. Tammany are less than if longleaf pine occurred to the total exclusion of other pine species, as in the case of Beauregard Parish. St. Tammany lies in the Forest Survey Unit No. 4. In its publication[10] on this unit, the Forest Service presents data showing that it, as in Unit No. 3 referred to above, is also badly understocked with timber and presents a distinct challenge to the State's ability to grapple with land use problems resulting from exploitation. On slightly more than half the forest area of 1,616,280 acres situated in this unit, the prevailing average volume of timber per acre is less than one-third of that found in Units in more productive condition. Although natural growing conditions are conducive to producing yields of approximately 300 feet board measure per acre per year, there was in 1934 an average of only 105 board feet of increment. For comparative purposes, however, it may be stated that the area is very similar to Unit No. 3, already described in connection with Beauregard Parish.

In the loblolly-shortleaf type, the five parishes chosen are DeSoto, Jackson, LaSalle, St. Helena, and Union, all considered to be representative of the parishes lying within this vegetational association. In all of these parishes there is a marked absence of public ownership. This forest type, described in the report on Forest Survey Unit No. 5,[11] is one bright spot in the forest resource picture of the State. In this Unit are situated DeSoto, Jackson, and Union Parishes used as representative of the type. Although St. Helen Parish was included in Survey Unit No. 4, its forest, economic, and industrial conditions are much more nearly comparable to those found in Unit No. 5. Stands of timber in this unit run somewhere between 9,000 and 13,000 feet board measure, the lighter volume being caused by the presence of hardwoods. The annual increment, on a weighted average basis, for the pine in this unit is 176 board feet, the highest for any unit of the State. This is merely a relative condition, for the report of the Survey on this Unit No. 5 states,

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[8] Forest Survey Release No. 43, *Forest Resources of Southwest Louisiana,* mimeo, Southern Forest Experiment Station, U. S. Forest Service, April, 1939.

[9] *Ibid.,* p. 33.

[10] Forest Survey Release No. 39, *Forest Resources in the Longleaf Pine Region of Mississippi and East Louisiana,* mimeo, Southern Forest Experiment Station, U. S. Forest Service, Mar., 1939.

> "Although the forests are at present in a state of rather low productivity because of frequent fires and short-sighted methods of cutting, the natural growth conditions are so favorable that it is possible, even now to change the present shrinking timber supply to an increasing resource that will continuously supply to the people of the unit raw material, employment, and a means of profitable land use."[12]

In the Delta hardwood type, an arbitrary selection resulted in choosing Madison and Concordia Parishes. Madison was the first choice because considerable land use study has been carried on there in connection with resettlement of the agricultural population. There are, moreover, some tracts of virgin hardwoods of high quality left in this parish. The parish has had stands of hardwood timber of unusually good quality. Concordia Parish was chosen largely because it is not contiguous to Madison Parish, but nevertheless lies wholly within the Mississippi overflow area. The Delta hardwood area is described in the Forest Survey report on its Louisiana Unit No. 1.[13]

As is the case with almost all the State's forest lands, the greater part of the forest has been overcut. The actual basal area of the typical acre contains only 56 square feet of timber of commercial species, although it could readily support 95 square feet. The Forest Service report[14] pointed out that approximately 60 percent of the sawlog volume is in inferior species, and 45 percent of the 60 is not used at all or is discriminated against. Because of heavy cutting in the past, not obvious to the untrained observer as is the case in Southwest Louisiana where there are large areas of clearcut land, 80 percent of the 2,689,900 acres of forest area in the Delta hardwood area is referred to as "non-commercial," meaning immature growing stock or low-grade material. The evidence collected by the Survey shows clearly that both the quality and quantity of the annual increment of the forest capital in Unit No. 1 are considerably below its productive capacity.

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[11] Forest Survey Release No. 31, *Forest Resources of Northwest Louisiana,* mimeo, Southern Forest Experiment Station, U. S. Forest Service, Mar., 1938.

[12] Forestry Survey Release No. 31, *op. cit.*

[13] Winters, R. K., Putnam, J. A., and Eldredge, I. F., *Forest Resources of the North Louisiana Delta,* U. S. D. A. Misc. Pub. 309, 1938.

[14] *Ibid.*

On the basis of the parish selections mentioned above, approximately 39 percent of the longleaf-slash forest area was covered, 28 percent of the loblolly-shortleaf, and 7½ percent of the bottomland hardwoods. Admittedly this is an uneven degree of sampling, but the longleaf-slash is extremely important because forest management in this type is difficult. For the loblolly-shortleaf type, which is the most important forest type from the standpoint of ease of management and rate of growth, sampling in a little more than a quarter of the land area is considered to be adequate. For the bottomland hardwood type, there is only a 7½ percent sample as represented by Concordia and Madison Parishes. Actually the sample is higher than 7½ percent because a great deal of the bottomland hardwood area lies outside the Delta, probably half or more, but the Delta parishes are considered superior to the more southern parishes, such as Iberville and St. Landry, in hardwood timber productivity. That the soil in the Delta parishes has excellent producing power as farm land is illustrated by the fact that a great deal of land clearing and resettlement is now going on in Madison Parish.[15] That Madison Parish also has highly productive forest soils is corroborated by the statement in a report prepared by the Southern Forest Experiment Station: "In the western part of Madison Parish is located the finest stand of red gum timber found anywhere in Louisiana."[16] The general drainage of Concordia Parish, on the other hand, is relatively poor, so the soil is incapable of producing either timber or agricultural crops to the extent that occurs in Madison Parish.

DATA SOURCE ON LAND OWNERSHIP

Public records, prepared and revised annually by each Parish Tax Assessor, served as the source of the data on ownership of private forest land. The present system of real property assessment was initiated about 1915 when an attempt was made to standardize all assessment procedures. Assessment records now contain the name and address of the title-holder, total acreage owned, description of property location, amount of homestead exemption, and an itemization of the millage levy by individual taxing authorities such as state, parish, drainage district, school district, levee district, and special road taxes.

In the assessor's description of the property, all agricultural land is classified as A, B, or C. The State's instruction to the assessors on this point is as follows: "The best land in cultivation in the parish shall be Class A, the next best Class B, and the next best, Class C. A taxpayer may own all three classes of land in cultivation."[17] Although for the purpose of this study these classifications had no importance, it was necessary to transcribe the amount of acreage in each land classification in order to obtain the aggregate amount of forest land attached to each farm.

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[15] Jones, Phillip E., Mason, John E., Elvove, Joseph; *New Settlement Problems in the Northeastern Louisiana Delta;* Louisiana Agricultural Experiment Station Bulletin 335, U. S. Dept. of Agriculture cooperating, 1941.

[16] Lentz, G. H., *Forest Conditions of Madison, Tensas, and East Carroll Parishes,* mimeo, Southern Forest Experiment Station, U. S. Forest Service, 1928, p. 14.

The reliability of the records which are found in the assessors' rolls relative to acreage of forest and agricultural land may well be questioned, for as noted above, the data were originally assembled as of approximately 1915. Certainly there has been a shift in land use between 1915 and today. The shifts in land use frequently do not appear on the assessors' rolls. Some errors are apparent in many parishes because corrections are not made until title to the property is transferred. In several parishes, however, the assessors take a keen interest in their job and make a sincere attempt to keep the property classifications up to date. There is very little incentive for an assessor, however, to try to maintain correct acreages as to quantity of land that should be classified as agricultural A, B, and C, and the various categories of woodland, for in most instances the rate of valuation for class C agricultural lands and all forest lands is the same. If the assessor attempts to determine the volume of timber on lands, he immediately becomes liable to public criticism. Assessors, therefore, are inclined to value lands with timber at an amount just slightly in excess of cutover lands. In Beauregard Parish, for example, from a taxation standpoint, it makes no difference whether the "forest" land has much timber of sawlog size on it, or is denuded, for it is all assessed at $3.03 per acre. In Concordia Parish, the land with timber of sawlog size on it is assessed at $4.99, as against $3.38 for land completely cutover for sawlogs. In Jackson Parish there is a spread of approximately $2.00 between clearcut and lands having sawlogs on them.[18]

CLASSIFICATION OF PRIVATE OWNERS

Forest Land Ownership Related to Land Ownership Objectives

A grouping of owners was made on the basis of the relationship that exists between the owner and his forest land. Three categories were adopted. These categories were designated as Class I, Class II, and Class III. A Class I owner is one who owns forest land as well as agricultural land in the parish studied. Usually the forest land was contained within the boundaries of the "farm." No attempt was made to determine whether the owner worked his agricultural land personally, or whether he surrendered partial control by renting or share-cropping. If an owner had title to three tracts of land, two of which were forest land only, but the third had some agricultural land attached to it, the owner would be considered a Class I owner. A holder of title to forest land, to which no agricultural land was attached, would be considered a Class II owner. An industrial unit, a user of forest products, such as a pulp mill or a sawmill, was placed in the Class III category. If a unit of a forest products industry held title to land, but had discontinued the activity of its manufacturing plant because of lack of raw materials, the owner was placed in the Class II category.

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[17] State of Louisiana, Department of Revenue, Division of Property Assessments; *Suggestions to the Assessors and Police Juries for the 1941 Assessment,* Baton Rouge, 1941, p. 4.

[18] Craig, Ronald B., *Taxes on Forest Property in Nine Selected Counties in Louisiana, 1937-1941; in Nine Counties in Alabama, 1937-1941; and in Seven Counties in Mississippi, 1936-1941;* Southern Forest Experiment Station, U. S. Forest Service, Occasional Paper 101, mimeo., 1942.

In Table 4 are data on the distribution of owners and the land owned according to the three classes used. The data show that three-fifths of the owners of forest land have an economic stake in agricultural land as well as forest land. In the Delta hardwood area, almost three-quarters of the number of forest land owners have a direct interest in agricultural land. In the loblolly-shortleaf type, two-thirds of the forest landowners have agricultural land also, but in the longleaf-slash belt, less than two-fifths of the owners of forest land are also owners of agricultural land.

In the loblolly-shortleaf and Delta hardwood areas, Class II owners have title to one-third and one-quarter respectively of the forest land. In the longleaf-slash belt, the Class II owners are distinctive. They own two-thirds of the forest land area and constitute the largest category of owners. In the longleaf-slash forest type, the Class I owners, the agriculturists, own very little of the forest land area, viz., 10 percent, in contrast to the loblolly-shortleaf and Delta hardwood type where three-fifths and one-half of the forest area respectively is held by the Class I owners. As pointed out above, the Class II owners hold title to almost two-thirds of the land in the longleaf-slash forest type, while in the other two types these owners hold approximately one-quarter or less of the area.

In the Class III category, the loblolly-shortleaf type is outstanding. The forest products industries own two-fifths of the land area in contrast to approximately one-third in the other two types.

Considering the subject of Classes of ownership and area owned from a statewide standpoint, the data show that there is a relatively large num-

TABLE 4.

Number of Private Owners and Forest Area Owned in Each of the Major Forest Types

Forest type	Percent of number of owners			Percent of area owned		
	Class of owner			Class of owner		
	I	II	III	I	II	III
Loblolly-Shortleaf	66.43	33.21	0.35	38.81	20.51	39.56
Longleaf-Slash	37.70	61.72	0.58	10.80	64.26	24.50
Delta Hardwoods	72.94	25.50	1.56	48.33	23.62	28.04
All Types	58.10	41.41	0.49	31.36	35.42	32.51

ber of owners in the Class II, or non-agricultural, non-industrial category. This group becomes even more important if regarded from the standpoint of *area* owned, for in this ownership category lies the largest land area in the State, with the industrial owners next, and the Class I owners least important, owning less than one-third of the forest land area. The Class III, or forest products industry owners have title to a greater percentage of forest land in the loblolly-shortleaf forest type than in any other type.

Mention has already been made that the area covered by this forest type is the most important in the State. From the data just presented above, it is evident and important to note that the units of forest products industry that wish to operate their manufacturing plants continuously have found that the loblolly-shortleaf type is conducive for their objective.

CLASSES OF OWNERS AND THEIR RESIDENCE

It has been assumed that proximity of an owner to his land implies a superior form of management. Conversely, if an owner lives at a distance from his property, management, and therefore, productivity, would be of a low order. Insofar as non-industrially owned forest land in Louisiana is concerned, there is lacking any conclusive proof to support the above-stated tenet. In spite of the recognized lack of proof, however, it was decided to classify forest land owners according to their residence relative to their forest land. Absentee ownership has sometimes been considered as constituting an important component of land owners. The data might show that there were marked differences between the forest types.

Table A in the Appendix shows several distinct differences between the forest types with regard to distance from residence of landowner and his forest property. In the loblolly-shortleaf area, with favorable natural and institutional environment for forest management, only nine percent of the forest area is owned by absentee Class II owners. This in marked contrast to the longleaf-slash area where 47 percent of the forest land is owned by Class II non-resident owners. In the longleaf-slash type, absentee owners account for two-thirds of the forest land.[19] In the bottomland hardwood area, one-half of the forest land is owned by absentee owners. In the loblolly-shortleaf type, it is lower, being only two-fifths. Several of the units of forest products industries are owned by non-residents. It is significant, however, that for the forest type that is least productive, non-resident ownership, largely concentrated in the Class II group of owners, should account for the title-holding to so much of the land.

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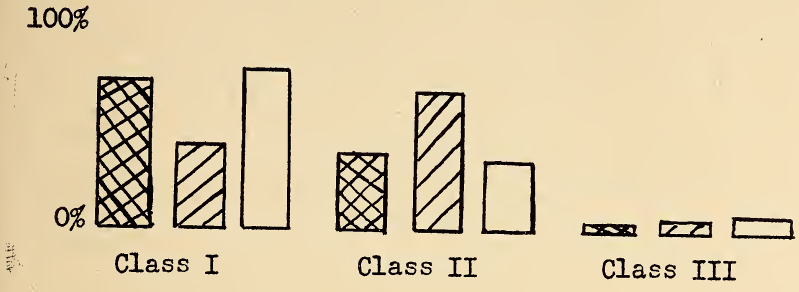
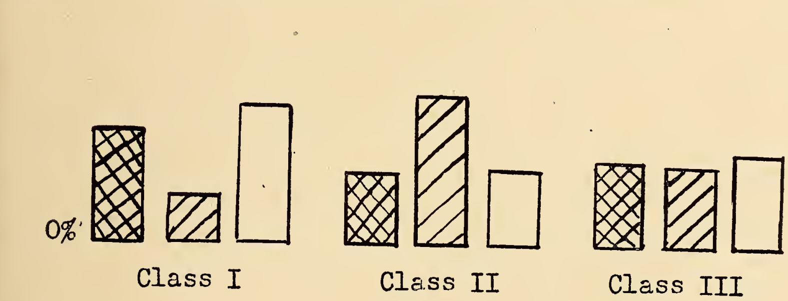
[19] An absentee owner is defined as one residing more than 25 travel miles from the property's closest point.

Ownership and Legal Identity

Owners in the nine parishes studied were placed in four categories, viz., individuals, corporations, estates, and partnerships. The first category, individuals, was further sub-divided into two classes, i.e., men and women. Inasmuch as women seldom acquire land willfully as a form of



Distribution of Number of Owners



Area of Land by Ownership Distribution

Explanation & Legends

forest types

▩ loblolly-shortleaf

▨ longleaf-slash

▭ Delta hardwood

Classes of forest landowners

Class I forest land as attached to farm units

Class II miscellaneous

Class III forest products industries

Distribution of Number of Owners and Area Owned by Major Ownership Classes in Each Forest Type.

wealth, it was assumed that, for the most part, the forest land owned by women was inherited.

The results of the groupings made according to legal identity reveal that individuals are by far the most numerous owners. They account for 83 percent of the total number of owners and for 39 percent of the forest land. If to the individuals are added partnerships, then almost nine-tenths of the owners are individuals. Corporations are not numerous as entities holding title to properties. They account for only two and two-thirds percent of the owners but hold title to 49 percent of all the forest land area.

TABLE 5.

LEGAL IDENTITY OF OWNERS OF FOREST LAND

LEGAL IDENTITY	FOREST TYPE			TOTALS
	Loblolly-Shortleaf	Longleaf-Slash	Bottomland Hardwoods	
	Percentages			
Men				
Number	61.50	71.98	65.66	64.89
Area	33.78	29.16	31.32	31.82
Women				
Number	18.70	17.84	12.60	17.99
Area	8.29	4.66	7.71	6.99
Corporations				
Number	2.37	2.58	6.80	2.68
Area	44.47	57.50	42.50	49.05
Estates				
Number	10.93	3.35	6.13	8.38
Area	7.20	2.36	3.89	5.01
Partnerships				
Number	6.50	4.60	8.81	6.06
Area	6.26	4.32	14.58	7.14

As shown in Table 5, there is no wide variation within any category of ownership between the three forest types. With regard to number of owners there is reasonably uniform distribution between the types except for corporations and partnerships. In each instance the number is higher in the bottomland hardwood type. Relatively, forest land owning corporations are almost three times more numerous in the bottomland type than they are in the other two forest types. In the case of partnerships, they are also more numerous in the bottomland area. In the case of estates, they are three times as numerous in the loblolly-shortleaf area than in the other two. This can probably be accounted for by the fact that the rolling uplands of North Louisiana have been settled for a longer time than the other two areas and have supported larger numbers of landowners than the other two. Cutover longleaf land is seldom good agricultural land, so agricultural development never flourished in the longleaf-slash type.

The forest type where a single group of ownership distinctly predominates the *area* is the longleaf-slash. In it, 60 percent of the land is owned by corporations. Individual men own only half that area in the same forest type. In the loblolly-shortleaf and bottomland hardwood areas, individual men own almost as much area as the corporations. For some reason, not readily apparent to the writer, the area owned by partnerships in the bottomland hardwoods is very high, being relatively twice as great as in the loblolly-shortleaf and three times as large as in the longleaf-slash.

Ownership and Size of Holdings of Forest Land

Data that have been presented above show that there are large numbers of owners. In the nine parishes studied, there are approximately sixteen thousand owners who own slightly more than three million acres of forest land. The data in Table 7 show, however, that size of holdings varies between forest types. In the loblolly-shortleaf area, two-thirds of the number of owners have title to units of forest land less than 120 acres, or a quarter section, in size. In the longleaf-slash area, four-fifths of the land owners have title to units less than a quarter-section in size. In the bottomland hardwood type, a little over half the owners have title to forest land of less than a quarter-section. The distribution of the *number* of owners in all forest types tends to be normal but skewed to the left. Units of ownership are smallest in the longleaf-slash area. The curve of the ownership distribution for the bottomland hardwoods is bimodal and less skewed to the left for the other two types. This means

TABLE 7

PERCENTAGE DISTRIBUTION BY AREA AND NUMBER OF OWNERS ARRANGED ACCORDING TO SIZE CLASSES AND FOREST TYPES

SIZE CLASS	LOBLOLLY-SHORTLEAF		LONGLEAF-SLASH		BOTTOMLAND-HARDWOOD		Total Number Owners	Total Area
	Number Owners	Area	Number Owners	Area	Number Owners	Area		
1 - 10	7.0	0.3	12.0	0.4	9.2	0.1	8.58	0.31
11 - 20	10.2	1.1	14.7	1.1	7.0	0.2	11.35	0.93
21 - 40	24.0	4.9	27.1	4.0	14.5	0.7	24.38	3.83
41 - 80	24.2	8.5	20.6	5.7	16.1	1.4	2 .64	6.26
81 - 120	12.6	6.9	8.0	3.6	8.0	1.1	10.96	4.70
121 - 160	8.4	6.3	6.5	4.3	6.5	1.3	7.73	4.74
161 - 320	8.2	9.7	5.8	5.2	11.4	3.6	7.66	7.15
321 - 640	3.5	8.1	2.7	5.4	10.4	5.7	3.65	6.76
641 - 1,280	1.3	5.7	1.3	5.1	6.5	7.4	1.58	5.81
1,281 - 2,560	0.5	4.5	0.6	4.7	5.6	14.9	0.81	6.48
2,561 - 5,120	0.1	2.0	0.2	4.8	2.3	10.1	0.25	4.45
5,121 - 11,520	0.05	2.4	0.2	12.1	1.4	15.6	0.19	8.05
11,521 - 23,040	0.05	5.8	0.1	8.4	0.7	17.2	0.10	8.79
23,041 - 46,080	0.03	11.1	0.1	12.1	0.3	20.6	0.07	13.19
46,081 - 69,120	0.02	7.6	....	....	....	....	0.01	3.79
over 69,120	0.02	14.9	0.05	23.2	....	....	0.03	14.84

that there are more owners with relatively large holdings in the bottomland hardwood type than in the other two.

The curve of distribution of *area* owned does not even approximate normality. It is worth noting that the loblolly-shortleaf area has the largest amount of forest *acreage* in units of less than one-quarter section, accounting for 22 percent of all the forest land. In contrast to this, in the bottomland hardwood parishes, only 3.5 percent of the forest land area is in units less than one-quarter section. Other contrasts are also evident. In the longleaf-slash type, almost one-quarter of all the forest land is in ownership units in excess of 69 thousand acres, while in the bottomland parishes there are no units larger than 46 thousand acres.

Discussion of Observed Characteristics Related to Ownership

It is evident that each forest type has characteristics that are peculiar to it. These peculiarities are both natural and institutional. The Class I owners, as compared with Classes II and III, are most numerous in the bottomland hardwood type in number of owners as well as area owned. The forest land problem is more closely associated with the farm ownership in the hardwood bottomland of the Delta than in any other forest type. The Class II owners are most numerous in the longleaf-slash type where they also own twice as much land as any other category of owners. Significantly, in this forest type, approximately three-quarters of all the Class II forest land is held "sticky" due to natural as well as institutional obstacles. The natural obstacles have already been discussed. The institutional difficulties will be presented below. The Class III owners are least numerous in the loblolly-shortleaf area but own the greatest amount of acreage. This is undoubtedly due to the silvical characteristics of the forest type, for it was the ability of the type to reproduce itself in spite of man, that attracted industry to the fact that, given some encouragement, the pine lands would become very productive and make it possible to continue the operation of the timber processing plants indefinitely.

Absentee ownership of Class I lands is distinctive in the bottomlands where large farms are characteristic. On the other hand, in the rolling upland area on which the shortleaf-loblolly type prevails, four out of every six Class I owners reside on their land and these resident owners account for half of the Class I forest land. Absentee ownership of Class I land in the loblolly-shortleaf area is unimportant. It is worth noting that in the loblolly-shortleaf area, where there is a great deal of forest land attached to farms, the resident and contiguous farm land or Class I owners are almost as important as in the bottomland hardwoods and very much more so than in the longleaf-slash type.

For the non-industrial owners as a group, i.e., the Class I and Class II owners, the area held by absentee owners is not important in the loblolly-shortleaf area, but accounts for approximately one-quarter of the area in the bottomland hardwood type and for almost half the area in the longleaf-slash.

II

PROPOSALS FOR INCREASING THE PRODUCTION OF TIMBER IN THE IMPORTANT FOREST TYPES

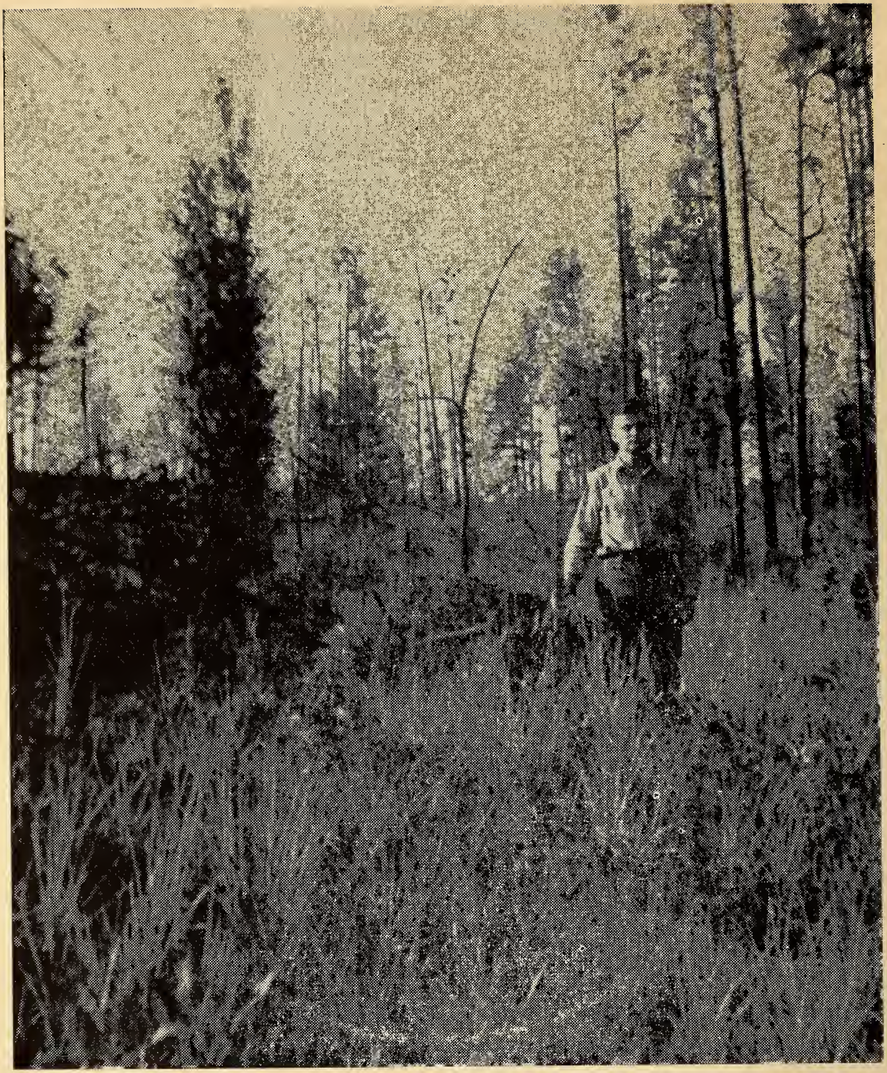
Inasmuch as each of the three forest types has ownership characteristics that are markedly different from the other two, any proposal to increase the productivity of the forest land must be related to the natural and institutional environment peculiar to each. Below are offered several alternatives that can be applied in each pine forest type to achieve the objective stated in the above topic heading. The merits and demerits of each alternative are discussed at some length in order that the reader may form his own conclusions concerning the validity of the conclusions herein presented.

THE LOBLOLLY-SHORTLEAF AREA

It has previously been mentioned that the forest capital and current productivity of the loblolly-shortleaf type is much higher than for the longleaf-slash. It has been found, however, that the productivity of the pine lands in the loblolly-shortleaf type varies with the class of owner. The non-industrial owners' lands are producing pine timber at only one-third their capacity. The industrially owned land, held by the Class III owners with large processing plants, is producing timber at slightly better than one-half its efficiency. The larger units of the forest products industries know that they can sustain their operations for an indefinite period if they have adequate resources. They have undertaken to assure themselves a supply of timber by cutting on their own lands as little as possible, by practicing partial cutting when they do cut their lands, and by purchasing more forest land and abandoned farm land whenever favorable opportunities present themselves. For the most part, the forest products industries practice forest management in varying degrees on their own land.

The need for more forest management is most acute on the non-industrially owned lands, the Class I and Class II holdings. The heart of the forest land problem lies in the non-industrial lands. In area owned as well as in number of owners, the non-industrial forest land owners are more numerous than the industrial owners. Approximately two-thirds of the *non-industrial* forest land area is owned by agriculturists or by people who own agricultural property. One-third of the non-industrial land is owned by non-agriculturists, i.e., people whose realty holdings, other than their homesteads, are forest land unassociated with agricultural land.

In the loblolly-shortleaf forest type, approximately one-third of the non-industrial forest land owners wish to produce timber continuously on their forest land holdings. The land of these owners is more productive of pine timber than that held by the other two-thirds who have no



Typical Stand of Timber Owned by the Agricultural and Miscellaneous Owners. There Is Inadequate Provision for Obtaining Young Timber.

interest in continuous timber production. In Table 8 are the data that form the basis for the statement just made. In the column that is headed "productivity of pine land" is entered an index number that could range from 0 to 10. An index number of 3.33 means, for example, that only one-third of the land that is able to produce pine is really occupied by it. In the case of item "k" in the table just referred to, the index number of 5.28 means that for the pine forest land owned by forest products industry, the land is being used more efficiently than the non-residential land,

TABLE 8

PRIMARY LAND OWNING OBJECTIVE RELATED TO PRODUCTIVITY OF THE NON-INDUSTRIAL OWNERS OF FOREST LAND IN THE LOBLOLLY-SHORTLEAF FOREST TYPE

	OBJECTIVE	Productivity of Pine Land
a)	Farming by owner	3.79
b)	Farming by tenant	3.45
c)	Explored sub-surface values	4.80
d)	Existing timber values	3.10
e)	Timber growing values	4.31
f)	Speculative surface or sub-surface values	3.08
g)	Grazing	3.76
h)	Farming and timber growing by owner	4.70
i)	Farming by tenant and timber growing on forest land	4.47
j)	Other values	4.23
k)	To sustain a forest products industry	5.28

some categories of which are only 31 percent efficient. The data on productivity show that approximately two-thirds of the productive power of the non-industrially owned pine land is being wasted; almost half the productive power of the industrially owned land is wasted. The productivity of the non-industrial land is dwindling, but the productivity of the industrially owned land is rising. In the case of the non-industrial land it is largely due to both heavy cutting and frequent forest fires. In the case of the industrial lands, it is due to a desire to protect the future operation of the processing plant by assuring itself of a supply of timber. The productivity of the industrial land would undoubtedly be much higher if there were fewer and less extensive forest fires.

OBJECTIVES APPLICABLE TO THE AREA

Forest conservation is desirable in the loblolly-shortleaf area because this will increase the contribution of a renewable natural resource to its economy. The economic vitality of the area rests primarily on the land, i.e., agricultural crops, cattle, petroleum, natural gas, and timber. Approximately 70 percent of the land area is forest land which is producing at less than half of its capacity. If capacity production could be achieved, or more closely approached than is now the case, there would be increased social benefits in the form of (a) more economic income to the non-industrial forest land owners, (b) more forest products industries, and (c) more opportunity for employment because of the greater need for men in the processing of timber. The State stands to gain from increased timber production the stabilization of communities dependent upon forest products industries. Forest land could be acquired by the several levels of government for the purpose of dedicating the land to timber production, thus assuring the industries of timber resources and men of employment opportunities, but the South apparently prefers to adhere to its tradition of private ownership of forest land. The essence of increasing the productivity of forest land, if the traditional ownership pattern continues, consists of convincing numerous owners that it is to their interest to practice forestry.

ALTERNATIVES FOR ATTAINING THE MAJOR OBJECTIVE

With a degree of public assistance against forest fires and a not too satisfactory law pertaining to taxes, several large units of the forest products industries have consciously tried to insure continuity of a supply of timber by increasing the forest capital, or quantity of timber, on the lands they hold in fee. If progress is to be made in increasing the timber productivity of the non-industrial lands, a program will have to be followed in which all parties that have a stake in greater timber productivity will cooperate. There are several basic approaches.

First Alternative

The first alternative would be based on the principle of extending more public aid to those forest landowners who have already demonstrated an interest in forest management, viz., several units of the forest products industries. This can be done through more effective protection from damage by forest fires, a more workable forest tax law that delays collection of taxes on crops of timber until it is severed, and an increase in the amount of forest tree nursery stock for planting badly cutover areas or abandoned farm land. All these items follow the pattern of public aid already formulated in the federal law generally known as the Clarke-McNary Law of 1924. Inasmuch as taxation of real property remains within the province of the several States, Congress can take no direct action pertinent to this field, but it does make available funds to supplement State and private moneys for protection of private forest land from fire. The State has made use of the Clarke-McNary Law. In the fiscal year 1940-1941, there were only 82 private cooperators in the five loblolly-shortleaf parishes covered in this study. In these parishes, however, there were 10,204 forest land owners. There were 1,522,579 forest acres of which 450,087, or a little less than one-quarter, were participating in cooperative forest fire protection.

Public assistance in tree planting has been given. Although tree planting has received much publicity, it has contributed very little toward maintaining the productivity of the loblolly-shortleaf forest type. Some planting has been done by the forest products industries, but the industrial unit that has planted most lies in the longleaf-slash type where planting is more necessary to rejuvenate the forest productivity of the land than in the loblolly-shortleaf type. Each year the large units of the forest products industries purchase more than half of the forest planting stock produced by the State Division of Forestry in its forest tree nursery.

The present tax law, commonly referred to as the Reforestation Contract Law, has not been widely utilized by the forest products industries. In 1942 there were only three forest land owners out of 10,204 in the loblolly-shortleaf area who had taken advantage of this tax law. These land owners hold title to approximately 41,389 acres out of the 1,522,579 acres of forest land.

It is quite possible that, given more public assistance in the task of timber production, the units of forest products industries could further increase the production of timber on their own lands. An argument in support of this public policy might be justified on the grounds that the task of increasing timber productivity on the non-industrial lands is too difficult because of the large number of owners involved and the general apathy of these owners toward forest conservation, evidenced by the low state of productivity of their lands. Rather than spend public money to overcome owner apathy toward forestry, it can be further argued, expenditures should be concentrated on the lands of the owners who already have shown an interest in forest management.

Second Alternative

The economic alternative would be to enlarge the public program of education and leadership among the non-industrial owners in addition to carrying out the program proposed in the first alternative. There already exists the necessary legislation and public administrative agencies to conduct an enlarged program of education and demonstration. Federal funds are already in use for this purpose. The State's funds for education and demonstration on the lands of the non-industrial owners are matched by federal money through authority of the Cooperative Farm Forestry Law, sometimes referred to as the Norris-Doxey Law of 1937. This plan would make available to the two groups of forest landowners, the forest products industries and the non-industrial owners, the sort of public assistance each needs most, i.e., more assistance in forest fire protection and leadership in the application of forest management respectively.

Third Alternative

A third alternative would be to use a master plan, founded on education and incentives, wherein the forest products industries would actively join the several public agencies in selling forestry to private owners. This procedure rests on a recognition of community-of-interest in forest land productivity. Forest lands owned by single units of industry are usually scattered. These holdings are interspersed among those of the non-industrial owners, the majority of whom are apathetic toward forestry. These non-industrial owners have as their primary motive for retaining title to their forest land some purpose other than the continuous production of timber. The non-industrial landowners who live on their land, or adjacent to it, or at a considerable distance, have no motive in preventing fires from burning on their own lands or on adjoining lands held by forest products industry. If genuine progress in timber production is to be made on the Class III lands, then a considerable number of the proprietors of the non-industrial land must be convinced that forestry is a form of land use that they, too, can employ to their economic advantage. Forestry has too long been regarded as applicable only to lands held in large blocks. The owner of a forty, or a few forties, is as much justified in practicing forestry as is the owner of 100 forties.

There is such an intermingling of forest lands in the three ownership categories, viz., industrial (Class III), agricultural (Class I), and miscellaneous (Class II), that each should recognize that there is a mutual advantage in practicing forestry. Only when many owners in each category of owners wish to practice forestry will substantial progress be made in forest fire protection and timber production. The forestry program of any industrial, as well as the whole related timber economy of the area, is seriously jeopardized by the apathetic attitude toward forestry by the non-industrial owners who are very numerous and who own three-fifths of the forest land.

Today public agencies concerned with forestry operate on a functional basis. The State Division of Forestry has concerned itself almost exclusively with forest fires, but has recently started educational work in forest management through demonstrations to some of the non-industrial owners on a few Norris-Doxey projects. The Agricultural Extension Service works at the forest management problem on farm lands also through a few Norris-Doxey projects, but is usually compelled to sell forest management without benefit of forest fire protection because of the nature of the forest fire protection system operated by the Division of Forestry. For example, 95 percent of all the forest land listed with the State for cooperative forest fire protection in 1943 is owned by corporations. Forest management is the synthesis of protection, silviculture, marketing, and utilization of timber and cannot be neatly compartmented. It rests on four legs. If any one leg is removed, it disturbs its equilibrium and utility. The non-industrial land certainly requires public assistance in protection from fires. But the non-industrial lands will not attain even reasonably high productivity unless some agency assumes leadership in providing it with forest fire protection as well as in carrying forest management practices to the landowners.

From the foregoing discussion it is obvious that a means to pool and implement the timber-producing objectives of all classes of land-owners must be designed. A Forest Conservation District, discussed in detail below, would make it possible to put to work the community-of-interest represented by the intermingling of forest lands of numerous owners. The interests of each group of owners needs to be pooled, through the democratic process, in an organized effort to increase the productivity of forest land in a specific locality.

Typical Stand of Timber Owned by Agricultural and Miscellaneous Owners
P. S. I. 8

The Forest Conservation District

There can be no doubt that the intermingling of owners of forest land in the loblolly-shortleaf forest type has created a community-of-interest in forest land. The productivity of the forest land of each owner is directly related to the attitudes that the adjoining owners have toward their forest land. There is an inter-dependence for adequate fire control which demands that each owner recognize and redeem his responsibilities as a landowner. One-third of all the non-industrial owners wish to grow timber continuously. Some of the remaining two-thirds will not wish to practice forestry, but many will, if given the opportunity, i.e., the necessary leadership and incentives. The larger units of the forest products industries wish to practice forestry. A vehicle is required to help all classes of owners to work together to obtain more timber production.

The most important single function of the District is to bring to a focal point local interest in forest conservation. The focus would occur through a five-member committee composed of local forest landowning citizens. The Committee would serve as the medium for establishing a partnership between the several private landowners and the public. Inasmuch as the public has a vital interest in having most of the privately owned forest land well managed, the State, assisted by the federal government, should be willing to (a) finance the cost of forest fire protection, (b) supply forest tree planting stock, (c) provide technical personnel necessary to administer forest fire protection and for the demonstration of forest management, (d) offer assurance of reasonable property taxation, including compensation to parishes for loss in revenue caused by Reforestation Contracts, and (e) assist landowners to secure credit when needed for forestry operations. All this activity in a district would clear through the Forest Conservation Committee.

In return for the public's assistance, landowners who wish to practice forestry should be willing to sign an agreement in which they request that their forest lands be examined by the Committee's forest technicians, that the foresters prepare simple recommendations for forestry practices that conform with standards determined by the Forest Conservation Committee, and that they agree to manage their lands in conformity with the recommendations.

Administrative Details

A Forest Conservation District would be a unit of government, within the State, having limited autonomy, and covering an area of 250,000 to 1,500,000 gross acres. Between one-half and three-quarters of this area would probably be wooded. The boundaries of a District would be established by the State forestry administrative agency. In order to activate a Forest Conservation District, 25 landowners, or landowners holding title to 20 percent of the forest land in the District, would be required to petition the State forestry agency for cooperation in forest protection and forest management. Upon the receipt of the petition, a referendum would be held. If a majority of the votes cast by the constitutionally qualified voters in the District favor the activities proposed by the District, it would commence to function.

Each District would be administered by a District Forest Conservation Committee of five persons, three of whom would be elected and two appointed. The Committee would establish rules of forest practice for the cooperating lands in the District. These rules would be within a broad framework of forestry practices prescribed by the State forestry agency.

All qualified voters in the District would be permitted to vote for the three Forest Conservation Committeemen chosen by his method. Two Committeemen would be appointed. One would be selected by the State forestry agency, the other by the State Agricultural Extension Service.

Qualifications for Committeeman would be that (a) he be a registered voter in the District, and that (b) he own in fee at least twenty acres of forest land.

Each District Forest Conservation Committee would be required to have an executive officer. His title would be District Forester. His sole qualification would be that he be a graduate forester. He would be selected by the State forestry agency after consultation with the District Committee.

The District Committee, through its Forester, would offer forestry aid to forest landowners. This aid would consist of (a) forest protection, (b) marking timber preparatory to a felling, (c) guidance in artificial reforestation, (d) aid in financing forestry operations, (e) recommendations for securing equitable taxation of forest land, (f) assistance in locating timber markets, and (g) other suitable forestry activities. This aid would be available only to the landowners who have signed an agreement that commits them to cooperating with the District Forest Conservation Committee. If an agreement has been signed, then aid as just described would be provided gratis.

The activities of the Committee would be financed by the State forestry agency supplemented by whatever other money was made available from private or public sources within the District. The amount of State funds alloted would be determined by the demonstrated needs of each District and the available resources. A Forestry District would have no taxing authority.

The plan just presented is based on the democratic process. Expenditure of public funds is justified by the fact that if there is a social gain from the practice of forest conservation, then society should be willing to bear some of the costs. The social benefits consist of community stabilization by producing forest resources upon which forest products industries depend for their operation, in the increase in taxable wealth created by more abundant forest resources and the industries dependent upon them.

Difficulties Operating Against its Adoption

The Forest Conservation District plan constitutes a means of amalgamating and unifying within specific, prescribed areas, activities of public and private agencies dedicated to increase the productivity of privately owned forest land. There are, however, several reasons that can be advanced for denying that it is a satisfactory vehicle for gaining the goal already stated.

An argument that can be advanced against its adoption is that it will require new State legislation. It is proposed that each District be a political entity with limited autonomy. Some people will contend, and not without cause, that already there are too many units of government.

What is needed is fewer, not more, political entities. Government, however, is part of the Anglo-Saxon tradition. It was originally conceived to provide a framework within which orderly progress could be made toward a socially desirable goal. It is this conception of government, rather than the negative, coercive sort, that would apply to the community-of-interest proposal referred to above as the Forest Conservation District. The critic of the District proposal may point out that the State Land Use Planning Committee[20] recommended that the Legislature pass an enabling act that would allow parishes to pass their own regulations with regard to forestry practices on privately owned lands. The disadvantage in this is that the police jury would hardly be qualified to devise and enforce satisfactory regulations. Admittedly it could consult with the State forestry agency, but the proposal advanced by the Planning Committee persumably would not make this mandatory. Even though it did, the Police Jury could still legally proceed to do as it wished and ignore any or all recommendations. The Sheriff is the law enforcement officer at the parish level of government, but it is very doubtful whether the Sheriff's office should be used to enforce regulations pertaining to environmental conditions on which good silviculture is based.

Critics of the proposal could well inquire why the forest land problem on the non-industrially owned land should not be attacked through the Soil Conservation Districts rather than through another unit of government as it is here proposed. The reason for proposing the Forest Conservation District, as another entity of government, is that the United States Department of Agriculture continues to attack the land use problem on a project basis. The Soil Conservation Service deals primarily with the soil. This gets it into contact with the agriculturists, inasmuch as they are the people who utilize the soil most intensively and therefore can most readily deplete its productive capacity. The Soil Conservation Districts, therefore, have primarily the agronomic rather than the comprehensive land use approach. Admittedly forest conservation is not ignored in the activity of the Soil Conservation Districts, but nevertheless, it receives only incidental consideration. The Agricultural Adjustment Administration and the State Agricultural Extension Service are closely allied with the Soil Conservation Service in promoting better forest management on farm forest lands.

The agricultural groups, however, cooperate with the forestry agencies, viz., the United States Forest Service and the State Division of Forestry. The Soil Conservation Service cooperates with the State Division of Forestry in the management of farm forest lands. It approaches this task through Norris-Doxey projects administered by the State Division of Forestry. The forest fire problem on the farm lands, therefore, becomes an orphan child because of the project approach. The Agricultural Extension Service cooperates with the United States Forest Service in contacting farm land owners, just as does the Soil Conservation Service in working with the State Division of Forestry. This cooperative work between the State Agricultural Extension Service and the United States Forest Service is possible because of the funds available through the Norris-Doxey Law, the same law which makes possible the working relationship between the State Division of Forestry and the Soil Conservation Service. The Agricultural Adjustment Administration has rewarded farmers for planting forest tree seedlings. When the financial inducements are large, some farm land owners plant forest tree seedlings. When the subsidy is small, few seedlings are planted.

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[20] State of Louisiana, *A State Program for Agriculture with Respect to Drainage, Forestry, Farm Tenure, Soil Conservation, New Land Settlement, Rural Health, and Housing;* State Land Use Planning Committee, Baton Rouge, mimeo, 1941.

The United States Forest Service is charged with extending forest conservation practices. As a Federal bureau, it is not concerned with crop land. It helps the industrial owner with forest fire protection through the State Division of Forestry, aids the farm owner via the farm forestry projects administered by the Agricultural Extension Service, and reaches the non-industrial, non-farm owner via forest farming projects directed by the State Division of Forestry.

It is likely that each public administrative agency will resist any development that will subordinate its own administrative function to that of the evident community-of-interest represented by the numerous owners of forest land in specific localities. The sober fact remains that if the community-of-interest approach is to be used, and it is the foundation of the Forest Conservation District proposal, then the several public agencies must surrender some of their vested interests.

A few years ago the "Tree Farm" idea[21] was born in the Pacific Northwest. It represents a drive by the forest products industries, particularly the lumbermen, toward getting more forest management on privately owned lands. The Pacific Northwest has an ownership pattern not dissimilar to that found in the South. Numerous non-industrial individual holdings are intermingled with the industrial ownerships. The forest products industries conceived the Tree Farm project as a means of implementing the community-of-interest in forest land productivity. In the Willamette Valley, for example, private forest land owners have pooled their lands under single management. For "Tree Farms" to become popular and attain their goal, the project needs a sponsor and that sponsor must have reasonable assurance of a continued existence. The "Tree Farm" plan and the proposed Forest Conservation District have an important feature in common. Both recognize the apathy toward forestry by the non-industrial forest land owners. Both propose to promote more forestry among the non-industrialists. The path that each follows to attain its goal, however, is divergent. The success of the Tree Farm plan rests primarily on the promotional ability of the sponsoring organization. No reward is offered for the social gain that is conveyed by forestry practice. In the Forest Conservation District plan, the social benefits of forestry practice are recognized by aids in technical guidance, forest fire protection, forest planting stock, taxation, and credit. Many private owners dislike any form of public participation in their activities. For this reason, Tree Farms might have considerable appeal. But in the Northwest, Tree Farms are sponsored by the forest products industries. In the South, this would have questionable value. The plan, however, requires a sponsor. If the State forestry agency acts as sponsor, the result will merely be further compartmentizing of forestry, an additional project in a field which is already overburdened with projects. The Forest Conservation District provides for a maximum participation of forest landowners in establishing their own standards of forest conservation. Offered as it is by a unit of government with adequate local representation the Forest Conservation District plan should allay any suspicion, by the non-industrial owners, that the plan has dubious merit because it promotes a project from which the forest products industries would be the principal beneficiaries.

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[21] West Coast Lumbermen's Association and Pacific Northwest Loggers' Association; *West Coast Tree Farms: The Next Step in Timber Growing in the Douglas Fir Region;* 1943.

The three alternatives that have been discussed above are intended to develop forestry through promotive measures. Another alternative, the one that follows, would increase forestry practices through the use of the police powers of government.

The Fourth Alternative

The fourth alternative would be to accept public regulation as sponsored by the United States Forest Service, or a modification thereof. This would certainly restrain the units of forest products industries in their cutting methods on the non-industrial lands. The proposal to use the police powers of government for achieving forest conservation is not new, but the Forest Service is becoming more insistent that the only way to attain the goal of forest conservation for the nation is through public regulation of timber cutting on all forest lands.[22, 23, 24]

Handicaps to the Use of Each Proposal

Each alternative that has been offered above has disadvantages and obstacles that can prevent the attainment of the chief objective. In the case of the first proposal, assuming more public money were spent on Class III or industrial lands for protection from fires, the emphasis would have to be on pre-suppression phases of forest fire protection. The history of forest fire protection in the United States shows that a reduction in the number of fires annually has been very meager. Possibly the edu-

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[22] United States Department of Agriculture, Forest Service; *A National Plan for American Forestry*, Document No. 12, 73rd Congress, 1st session, 1933.

[23] United States Department of Agriculture, Forest Service; *Report of the Chief of the Forest Service*, 1940.

[24] Watts, Lyle F., "Comprehensive Forest Policy Indispensable," *Journal of Forestry* 41:783-791, 1943.

cational methods employed for preventing forest fires can be improved. Results obtained from educational methods are difficult to determine with any degree of accuracy. Numerous fires are due chiefly, however, to public apathy. Since the *number* of forest fires can't be very well controlled, fire protection agencies have tended to emphasize the phases that make it possible to control fires before they became large. It is reasonable to expect that, instead of expending more public money on protecting a specific category of land, it would be preferable to demonstrate to the non-industrial landowners the economic advantages of practicing forestry. In so doing, a public sentiment would be built up, among the people who own and live on the non-industrial forest land, that would lead to reducing fires caused by carelessness and eventually outlaw uncontrolled forest fires. Acceptance of the first alternative would be a poor one inasmuch as it would not have the cooperation of the 99 percent of the forest landowners who have title to 60 percent of the forest land. Expenditure of funds for forest fire protection, with emphasis on pre-suppression and suppression, soon reaches the point of diminishing returns.

The second proposal attacks directly the problem of increasing the productivity of the non-industrial lands through overcoming the apathy of the non-industrial owners toward forestry. It, too, contains a distinct weakness; e.g., it consists of drawing a line of distinction between the industrial and non-industrial owners. As pointed out before, there is actually a community-of-interest, recognized or not, in all wooded areas in the forest type under discussion. The non-industrial forest land problem has been, and now is, approached chiefly through Norris-Doxey projects administered by three separate State and Federal agencies. Forest management is stressed on farm forestry and forest farming projects without the organized public assistance, through the Division of Forestry, against forest fires. The basic weakness lies in the project approach, compartmentizing forest management and fire protection activities. The alternative under discussion rests primarily on increased public funds and therefore on leadership by government rather than from local, grass-roots belief in the project. The weakness of this approach lies in ignoring the principle of the community-of-interest everywhere evident in the loblolly-shortleaf area.

The fourth alternative is founded on the use of the police powers of government. The bills that have been introduced into Congress to implement the Forest Service proposal place the whip hand in the Federal government. In the Federal proposals, the democratic process has been ignored; forest conservation is to be achieved through coercion. Public regulation, especially that emanating from the federal level of government, is diametrically opposed to the grass-roots, democratic form of control comparable to that which is now used by Soil Conservation Districts. Regulation of itself is negative without accompanying positive action. If forest fire protection administration is left to each State, as assumed by recent federal proposals, it further assumes that each State is willing and able to bear the increased financial burden. But there is no advantage in attempting to increase forest land productivity without adequate protection from fire. The Federal proposal still further assumes that owners of forest land depleted of timber will be willing and financially able to plant forest tree seedlings. With the taxation of forest land a prerogative that rests with each State, and its lesser units of government, it must be further assumed that the various levels of government will control taxation so that timber cutting controls will not result in direct confiscation of forest land. These assumptions may all be faulty. It is extremely doubtful whether public regulation, as now conceived by the United States Forest Service, will achieve the results desired.

Several States have recently enacted regulatory legislation. The first was Oregon in 1941, and more recently, Maryland. Inasmuch as this technique for obtaining forest conservation in the United States is still new, it is now too soon after the initiation of the efforts of the State to make a satisfactory appraisal. Oregon is a State which has a large economic stake in maintaining the productivity of forest land. The lumber industry is reputed to have supported the regulatory legislation. The economy of Maryland, on the other hand, is not nearly so dependent upon timber resources as is that of Oregon. The success of the legislation will be determined by the manner in which the State Forester's authority is employed.

Longleaf-Slash Area

Of the three major forest types in the State, the longleaf-slash ranks lowest in several ways. Data have been presented showing that the forest capital, per acre basis, is only one-third of that of the loblolly-shortleaf area, in which the productivity of the forest land is less than one-half its potential capacity. The depleted condition of the forest land in the longleaf-slash type is due to both natural and institutional obstacles. There exists an inter-relation between the two that cannot be ignored and, by the same token, require joint consideration if the surface of the area will be restored to its former productive condition.

Recapitulation of Outstanding Characteristics of the Area

The forest land is owned predominantly by Class II owners. This ownership category accounts for 64 percent of the forest land. Only 11 percent of the land area is in Class I holdings. In number, the Class II owners are typified by non-resident owners, chiefly persons residing either in the Mid-West or the vicinity of New Orleans. In area, the Class II owners are typified by forest products industries that have liquidated their timber assets. The land is the residue of their former manufacturing operations.

Corporations account for only three percent of the land owners, but for 60 percent of the area. Individuals, mostly men, own 34 percent of

Cut Over Land Made Productive Through Planting.

the land area. In St. Tammany Parish, a large number of individuals, relative to other parishes, cooperate with the State Division of Forestry in forest fire protection. In contrast to St. Tammany Parish, the other parish selected for the longleaf-slash area, viz., Beauregard, has very few cooperators in forest fire protection.

Large land holdings are found in this forest type. Almost one-quarter of the land area is held in single ownerships of more than 69,000 acres. Sixty-five percent of the forest land area is in ownership units in excess of 1,280 acres.

The silvicultural characteristics of longleaf pine have been referred to previously in this paper. This species not only has peculiarities that deter natural reproduction, but the forest fuels that are found on longleaf sites are conducive to frequent forest fires. In St. Tammany Parish, where slash pine mixes with longleaf pine in the flatwoods, the first-mentioned species reproduces easily, provided there are present a number of seedtrees and fire is excluded or adequately controlled. Very seldom are both of these requirements present.

Longleaf and slash pine almost invariably utilize soils that, for most agricultural purposes, is considered inferior because of the compact B horizon. For this reason fewer of these lands have moved into agricultural use than is the case in the other forest types. Land title has therefore become "sticky." With large acreages of forest land on their hands, title "stickiness" probably made corporations speculators in sub-surface values. Title has been retained to the surface only because it gives the owner control over sub-surface values.

THE INFLUENCE OF SUB-SURFACE VALUES

More than a decade ago there began an eastward movement of exploration for geological formations that are likely to produce petroleum. Even on the remotest forest truck trails in Louisiana today one finds tags, colored paper, and colored cloth indicating that seismograph crews have been in the area prospecting for the subsurface geological structures that contain petroleum. The individual landowners have had their speculative appetites whetted by oil companies who have taken out leases on land for the privilege of drilling and, if petroleum is found, return to the owner, provided he still owns the mineral rights, a fraction of the value of the petroleum at the time it is removed. The very logical effect of this has been for those people who own forest land, particularly forest land detached from a farm unit, to retain title rather than risk the chance of not being able to cash in on a possible future value. This fact is probably one of the outstanding reasons why the State has relatively little tax delinquency as compared with some other southern States, and why land seldom remains tax delinquent very long. Viewed from a short-term point of view, this situation is one that benefits the private landowner tremendously because of the income he derives from mineral lease payments on his property. These payments range anywhere from $0.25 to $1.25 per acre per year. If a substantial amount of acreage is owned, the landowner derives an excellent income in spite of the condition of his forest land. Through the leasing arrangement, exclusive of royalties paid for the removal of petroleum, millions of dollars annually are paid to landowners. Even under favorable circumstances and good management, the income from the production of timber would scarcely be in excess of $2.50 per acre per year.

In the case of lands under oil lease, the income to the owner from these oil leases, or any royalties obtained from lands that have producing wells on them, is seldom used to create or increase surface values in the form of forest capital. Instances could be cited where some forest products industries have increased their land holdings from revenue derived from petroleum production, but these are very small in number. In other words, the petroleum industry acts as a deterrant to the practice

TYPICAL VIEW OF FOREST LAND THAT WILL PRODUCE ANOTHER CROP OF FOREST TREES ONLY IF PLANTED.

of forestry on lands where the natural obstacles to forest management are high.

When one considers the nature of the mineral rights in Louisiana, it is quite understandable why it is distinctly to the advantage of the landowner to retain full property rights to his forest land, even though the land has been exploitive to the extent of reducing the forest capital to a negligible amount. If the landowner permits his property taxes to become delinquent, then the parish either sells the land for at least the taxes outstanding against it, or permits title to be adjudicated to the State. In any event, the landowner loses control of all his rights to the property, including his mineral rights. On the other hand, the landowner is unable to convey fee simple land title to another person or corporation and retain an interest in the mineral rights for a period in excess of ten years, for Louisiana law considers the ownership of mineral rights held by someone other than the holder of the surface rights, to be in the nature of a servitude. Daggett states, "Article 618 of the Revised Civil Code of 1870 declares the life of a discontinuous servitude to be ten years unless this prescriptive period is interrupted or suspended or extended."[25]

With so many owners of forest land continuing to hold title because of the speculative appeal, it would seem that they would be willing to lease the surface rights for a long period of time to forest products industries or individuals primarily interested in timber production. In this manner their financial obligations would be reduced, for the arrangement would at least cover the property taxes levied against the land and timber. Owners are extremely reluctant to do this, for although their primary interest in the land pertains to the mineral rights, the great majority of owners tenaciously cling to the surface rights, even being unwilling to seriously consider the subject of leasing them for timber production.

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[25] Daggett, Harriett Spiller; *Mineral Rights in Louisiana,* Baton Rouge, 1939, p. 33.

ALTERNATIVES

In the longleaf-slash forest type, certainly for the type as it occurs west of the Mississippi River, the community-of-interest is not present to the degree found in the loblolly-shortleaf type. The natural obstacles to the practice of forestry are high and are reflected in the denuded condition of approximately a million acres, or one-third of the area now occupied by the type. The natural difficulties, coupled with institutional factors, present a situation of a much different sort than the one encountered in the loblolly-shortleaf area. It is recognized that within the longleaf-slash type there are areas in which the community-of-interest proposals are applicable. The alternatives that will be discussed would apply only to the lands of the longleaf-slash type where the community-of-interest is absent and where the natural and institutional obstacles create an environment unsuited to the practice of forest conservation by private owners.

It is assumed that the public can not expect a private forest land owner to make large capital expenditures in order to rehabilitate forest land. Most landowners are "economic men." Where the productivity of forest land must commence by planting forest tree seedlings, i.e., if the land is almost bare, or worse, covered by weed species, the chief beneficiary from the land's restoration to productivity will be society. The lifetime of an individual financially able to undertake such reforestation expenditures and attendant risks would be inadequate to enjoy the financial benefits of such an undertaking. Therefore, where large capital investments on a per acre basis are necessary in order to rehabilitate forest land, the public will have to assume a very positive role and bear the whole cost. There are at least two land economists, however, who believe that there are private owners who would be willing to borrow capital in order to reforest cutover lands. Hammar and Mussman[26] are exponents of a plan whereby the Federal government would practice forestry on leased private lands, borrow money for this purpose from a Federal credit agency created for making loans of this type, and then return to the landowners an agreed-upon share of the stumpage value of the forest products at the time they are severed. The whole plan, however, assumes that the owner is willing to enter into an agreement of this sort and pledge his land as collateral. It is extremely doubtful whether this assumption is correct, especially in Southwest Louisiana where over 1,000,000 acres of cutover longleaf pine land will produce timber again only if reforested by planting or through other measures, where the landowners' greatest interest is in sub-surface values.

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[26] Hammar, Conrad H. and Mussman, Albert H., "Interest and Credit Costs in Forest Restoration," *Jour. of Forestry* 38:37-43, 1940.

There are several possibilities that can be considered: first, the State request the Federal government to purchase the lands for use as national forests; second, enact enabling legislation to allow the State to lease the surface rights of the forest lands; third, the State take title by use of eminent domain if the owners persist in refraining from using the surface merely in order to have title to the subsurface rights; fourth, increase the assesments of unproductive forest lands if the owner is unwilling to lease the surface rights, thus forcing these lands into public ownership through tax adjudication, and then have the State rehabilitate them; and fifth, abandon the idea of having the lands produce crops of timber, but dedicate them to the production of livestock instead of timber. Each proposal will be discussed below.

FEDERAL OWNERSHIP

The chief advantage of having the Federal government purchase the lands would be that of relieving the State from financing the operation, for the investment necessary for such an undertaking would be considerable. If the lands were used for National Forest purposes the State would benefit from eventually having forest resources utilizable to increase employment opportunities. The Forest Service has abundant experience in the administration of forest land and an excellent record for redeeming responsibilities attendant upon stewardship. An important disadvantage to Federal acquisition would be lack of current income from taxes now accruing to local units of government. Today there is relatively little tax delinquent land in the areas where the depleted forests are. Private ownership is very tenacious because of the sub-surface speculative values. If private ownership rights are forfeited to the public because of lack of payment of taxes, the owner loses all rights: rights to the surface, sub-surface, and supra-surface values. Hence private ownership continues in the unproductive forest land.

As was commented upon at some length earlier, the desire to retain title to mineral rights constitutes an obstacle to the transfer of title to land. The owner continues to hold title to his land depleted of forest resources, even though the sole purpose in retaining title is speculative in sub-surface values. With no intention of ever practicing forestry, he will be unwilling to convey title to the Federal Government unless he is permitted to retain indefinitely his rights to the sub-surface values. With Louisiana's present mineral laws, however, this is impossible. There is ample precedent for the Forest Service's procurement of title to land wherein the private owner reserves the mineral rights indefinitely, but this has occurred only in States with mineral laws permitting this. It would seem that most landowners, at least those who retain title purely because of its speculative appeal, would be eager to relinquish the surface rights and their attendant obligations such as payment of ad valorem taxes, if they would be permitted to retain the mineral rights for more than a ten-year period. In its present form the servitude interpretation of the mineral rights presents a tall, although not necessarily insurmountable barrier.

In order to make public acquisition attractive to the private owner who attaches so much value to sub-surface rights, the Federal government could make arrangements to lease to the owner, for a very nominal sum, the mineral rights. It is possible that the legal department of the Federal government would object to acquiring title when sub-surface rights would be assigned to the previous owner, but precedent has been established for such action by land purchase for national forest purposes under comparable conditions in Pennsylvania.

OBTAINING OWNERSHIP OF LAND THROUGH COMPULSION

The acquisition of surface rights, or title in fee discussed above implies a willing buyer and a willing seller. In event that the present owners are unwilling to relinquish control over the surface rights, then the State can resort to its power of eminent domain and acquire title so that the surface can be put to work. This would be a very drastic step to take in a State that traditionally has attached so much importance to the rights of private property. With sub-surface values so difficult to estimate, the acquisition of title through the power of eminent domain might cost the State an excessive amount. Public opinion would probably not approve such action. It would be justified only if there could be established a clear, vital need for putting the surface of these lands to work producing timber. For the public to accede to such action would require a much more acute need for timber supplies than now exists or will exist in the near future. Although an objective analysis of the problem calls for putting the surface to some use, and timber production is well adapted to the soil and climate, the realism of the situation prevents the use of the State's right of eminent domain as the means of rehabilitating the forest land.

Assuming an unwilling seller, another alternative would be to raise assessment values to deprive the owner of his title by forcing the land into tax delinquency, let title be adjudicated to the State, and then utilize the surface for producing timber. This procedure, however, would not be valid under the present tax laws. The method, moreover, would be more vicious than the use of the State's right of eminent domain which would compensate the owner for the rights of which he has been deprived. High taxation is confiscatory and should not be seriously considered as a means of acquiring title.

DEDICATE THE LANDS TO GRAZING

There is also the possibility that the lands that have been exploited excessively for forest products and require large sums of capital to rehabilitate them should be used for some purpose other than forestry. A use that has possibilities is grazing, although this land use is considered even more extensive than forestry and as such, yields less land rent. The other factor that operates to the advantage of using the land for timber production rather than grazing purposes, the commodity that is produced, viz., beef or mutton or lamb, is a consumer commodity that requires very little processing to prepare it for the market. In the case of timber production, however, the logs or bolts from the trees must be processed before they can move into the consumer market. This processing requires the use of men and heavy equipment.

Where grazing is conducted on forest lands, those lands whose highest use is really timber production, there almost inevitably occurs a clash of interests. The decision as to whether the cutover longleaf lands of Southwest Louisiana should be used for livestock production or timber production should be based on the highest use to which the land can be put. Pearson[27] presented data which showed that even in the region of slow-growing timber, considerably removed from consuming areas as on the Cocconino Plateau, timber production, exclusive of the employment opportunities made possible by industries dependent upon it, yielded a land rent superior to that returned by livestock production. Until there is evidence that grazing on the cutover longleaf pine forest lands is a higher form of land use than forestry, it will be assumed that the land should be dedicated to timber production rather than grazing.

STATE OWNERSHIP OR CONTROL

There are several factors that operate against State acquisition of title to the forest lands requiring large capital investment to rehabilitate them. The first is the same as discussed in detail above, viz., the subsurface values. The second is the task of financing of the reforestation and protection during subsequent years. The third factor is the traditional aversion of the political leaders of the State toward ownership of land. Earlier in this paper there was a discussion of the several Acts of the State Legislature, convening in the depression period, to allow title to land to remain in private ownership. Undoubtedly much of the land that was redeemed was reclaimed because of its mineral and subsurface value rather than because of the desire to utilize the surface for some productive purpose such as grazing, farming, or forestry. The mineral rights, however, could not be redeemed from the collector without acquiring the surface as well, so the surface rights were acquired also, although probably purely incidentally to the mineral rights.

A fourth factor that seems unfavorable toward having the State acquire land for state forest purposes is lack of experience in administering publicly owned forest land for purposes of State Forests. The critic of this observation could well point out that there always has to be a beginning sometime and that some other States appear to be able to manage their public forests quite efficiently.

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[27] Pearson, G. A., "Forest Land Use," *Jour. of Forestry* 38:261-270, 1940, p. 264.

The legal aspects of the matter of public acquisition, either Federal or State, of title to forest land depleted of its forest capital is such that it is very doubtful whether substantial amounts of land could be acquired in fee. It is questionable, moreover, whether the Federal government would be willing to lease forest land for national purposes even though this was the basis offered by Hammar and Mussman for obtaining control of forest land. There is no institutional obstacle that would prevent the State from leasing the surface rights. The State has no precedent to break in taking action of this sort. The facts just listed lead to the conclusion that the State would be the logical level of government to practice forestry. Because of the difficulties in acquiring title in fee, the surface rights should be leased for a long period, e.g., 99 years.

If lands are leased, the annual fee for this privilege should not be much, if any, in excess of the annual property taxes. The surface is probably yielding no income whatsoever to the present owner. Actually the owner wishes to preserve his property rights only in the sub-surface, so is relinquishing nothing valuable when he gives up control of surface rights. These are important to the owner in that control over them gives him access to the values below the surface. In theory, at least, the cost of leasing the surface rights should therefore be small.

Referring to precedent, viz., the general policy of the State avoiding the acquisition and administration of public forest land and approval given previously by the State for the purchase of land by the Federal government for national forest purposes, the natural course indicated is the extension of the national forest area in Louisiana. The institutional obstacles to this procedure, however, are so great that the only practical alternative would be for the State to depart from precedent and acquire control of the surface, make the necessary investment, and commit itself to the policy of providing good administration for the State forests.

SUMMARY OF RECOMMENDATIONS FOR PINE LANDS

There has been in this paper a great deal of discussion of the relationship of government, as an institutional factor, to forestry. Two levels of government are now involved in taking public forest aid to the private landowner. Federal funds made possible by the Clarke-McNary and Norris-Doxey Laws channel to the private owner through the State Division of Forestry. There seems to be no genuine obstacle to using Federal funds, available through the above-mentioned Federal laws, in the proposed Forest Conservation Districts. The Norris-Doxey projects should be located entirely within the boundaries of Districts. This action would be to the distinct advantage of the cooperative farm forestry projects, for forest fire protection would be available to all forest lands under agreement in the Forest Conservation District. Protection would be extended only to those lands lying within Districts. There would be no more injustice in this procedure than is the case today where protection is withheld from small landowners because of the absence of several large tracts also demanding protection. After following a pattern of State and private relationships for twenty years, it will be difficult to break through the "hardened cake of custom," but it will be necessary to do this if there is to be progress toward increasing the productivity of the private forest lands by use of intensive education. There will be numerous administrative difficulties to overcome. The Federal agencies, particularly the Forest Service and the Soil Conservation Service, will have to be convinced of the merits of the changes, and the Class III landowners, very influential cooperators, must be shown that the adoption of the plan will, in the long run, not be harmful.

The cost of that part of the revised program dealing with private owners would be approximately $440,000 as compared with approximately $400,000 that the Division spends today. There are numerous indications that the Federal government will finally appropriate more funds for forest fire protection, so the State should expect more Federal financial assistance. This would probably more than offset the loss of approximately $30,000 of private funds now collected from cooperators in forest fire protection. An increase of $150,000 should, therefore, enable 'the State Division of Forestry to carry on its increased educational activities. This would mean increasing the State appropriation for the Division of Forestry from $250,000 annually to $400,000.

In the event that the State decides to rehabilitate the denuded forest lands, amounting to approximately 1¼ million acres, the magnitude of the cost will be much greater than for the educational work. Assuming that the cost of planting would be $5 per acre, the project would require a capital expenditure of $6,250,000. If money could be borrowed by the State at four percent, debt retired in 25 years at the rate of $250,000 annually, cost of administration at ten cents per acre per year, cost of leasing surface rights at $0.25 per acre per year, the annual cost to the State would be $765,000. At the end of twenty-five years, however, the State would have 1¼ million acres of very productive forest land that should be capable of producing a gross initial revenue of approximately $1,000,000 per year, increasing to $2,500,000 in another fifteen years. The cost to the State of transforming a liability of wasted surface resources to an asset would be approximately $20,000,000 twenty-five years after the work was started and when the property could be considered a going concern. These values are exclusive of the social gain that would accrue to the State through making available a resource used by forest products industries. The expansion of these industries will provide greater employment opportunity in the State, a goal that is certainly desirable.

The Bottomland Hardwood Forest Type

Attention has already been called to the large area of the State's forest land that supports the bottomland hardwood forest type. By virtue of topographic conditions, Louisiana has had not only splendid stands of pine timber, but also hardwood forests unsurpassed by any in the United States. Even today, after a good many years of exploitation, the hardwood forests produce approximately one-third of the lumber produced in the State.

Culled Bottomland Hardwood Area.
Photo by U.S.F.S.—from unnumbered mimeograph paper—S.F.E.S.—6/1/28

Mention has already been made that very little is known with regard to the way in which the bottomland hardwoods and of timber should be handled. A large part of forest management consists of converting what is now culled-over stands of timber into forests of species in good commercial demand. The subject of forest management, therefore, is inexorably identified with the utilization of a great volume of low value species that now characterizes the timber on the hardwood bottomlands. The demand for hardwood lumber is limited. The local pulp industry prefers to avoid using hardwoods. The hardwood veneer industry is very selective in the species it is willing to process. For these reasons, forest management in the bottomland hardwood area has not made much headway. Because progress in management is so directly associated with the problem of utilization of low-grade hardwoods, no recommendations will be made with regard to increasing the productivity of the bottomland hardwood area. Until the specialists in utilization solve the inferior hardwood problem, there will be little progress toward achieving widespread forest management except on sites conducive to species in good demand such as red gum and cottonwood.

III

COMMENTS ON THE REFORESTATION TAX LAW

One way in which the State has endeavored to encourage the private owner of forest land to produce timber continuously is through what is commonly referred to as the Reforestation Tax Law. This was enacted in 1924 and has remained on the statute books ever since.

In the nine parishes studied intensively in the investigation in 1941 only four landowners had listed 29,242 acres under the terms of the contract in the loblolly-shortleaf area, 30 landowners had listed 45,105 acres in the longleaf-slash area, and none in the hardwood bottomlands.

This is evidence that the contract has not contributed very much to progress in forest conservation. It might be assumed, for example, that the extent to which landowners take advantage of the reforestation contract is an excellent criterion of the owners' intent concerning forest land management. It should not be concluded, however, that for an owner not to enter into a reforestation contract with the State implies an absence of intent to practice forestry. There are several handicaps to the more widespread use of the Law.

The essence of the reforestation contract is as follows:

1. Land and timber are taxed as separate entities.
2. The valuation of the land is determined by the local police jury at an amount somewhere between $3 and $8 per acre. This valuation will last the life of the reforestation contract.
3. The police jury representing the parish (county) is a party to the contract.
4. Taxes levied annually against the land are payable under the usual system of collecting taxes on real property.
5. Taxes on the timber are paid only at time of cutting. Cutting may be done only with the sanction of the state forester and subject to those restrictions created by him.
6. The rate of payment at the time of timber severance is six percent of the stumpage value.

7. The funds obtained through the deferred timber tax at time of severance are divided into four equal parts, three of them going to the local parish and one to the general fund of the state.
8. Contracts are limited in duration to forty years.
9. There is a penalty on the private owner for voiding the contract.

There are two outstanding obstacles for the private owner to overcome before he signs a reforestation contract. First, the police jury of the parish in which his lands are located must give assent to entering into a contract of this sort; this implies agreement as to the assessed value of the property. The statute on the subject states that the assessed value must be between $3 and $8 per acre. If, for example, the police jury wishes to list the lands at an assessed value of $7.50 per acre, the landowner might consider this amount excessive. If, unable to persuade the police jury to assess the land closer to the allowed minimum, especially if his land is already assessed at that amount including the timber, there is no incentive to enter into a contract with the state. Police juries appear to be reluctant to commit themselves for a long-time assessment on a nominal basis, even though such action would, in the long run, be conducive to increasing the taxable wealth of the parish. Most police juries have the short-run point of view, for they are confronted continually with obtaining current revenue to carry on parish functions. Almost the only source of revenue left to the parish by the Federal and State governments is that derived from taxing real property. If a large amount of forest land in a parish is placed under reforestation contract, the police jury is liable to criticism from the remaining land owners, even though many of these same owners have had their tax burdens lightened through the Homestead Exemption Law. The net effect of the widespread use of the reforestation contract is to narrow the parishes' tax base.

The second obstacle that stands in the way of greater participation among landowners in the reforestation contract is their dislike of being subject to the control of the State Forester's office when a cutting is made.

As of January 31, 1942, there were 608,701 acres of forest land listed under the reforestation contracts. These represented 63 separate ownerships, but 113 contracts. This forest land area was 3.7 percent of the State's forest land. When one keeps in mind, however, that forest management has been made popular on only the pine forest land of approximately 7½ million acres, there is the figure of 8 percent that confronts us as being more nearly correct than the above mentioned 3.7 percent. It is significant that many of the large holders of forest land have refrained from entering into a reforestation agreement. For example, although approximately 450 forest land owners have listed 2,250,000 acres of their forest land for cooperative protection, only 63 of these owners have entered into a reforestation contract for a total of 608,701 acres. In the nine parishes studied intensively, only three contained forest land under a reforestation contract, representing only 14 owners out of almost 16,000 and 62,347 acres out of 3,100,000. It appears, therefore, that short-term contracts characterized by the fire protection agreements are preferable to long time ones such as the Reforestation Contracts.

SUGGESTED REVISIONS

In order that the reforestation contract can become operative to the fullest advantage, it is suggested that the changes in the Reforestation Contract Law be made as follows: (a) The assessment levied against the land should be a uniform amount in all parishes, rather than an amount between $3 and $8 per acre, set at the option of the Police Jury concerned. An assessment of $3.00 or $4.00 would probably be adequate. The millage levied against the assessed valuation ranges from 30 to 70 per dollar value. Taking the mean of these two figures, being 50, with valuation at $3.00 per acre, the income to the parish would be $0.15 per acre per year. Add to this the amount proposed below and the income to the parish, on a per acre basis, would probably be in excess of what most parishes are now obtaining on lands not under reforestation contract. (b) The clause requiring the approval of the police jury should be deleted. The outstanding argument for having the police jury a party to the agreement is because the income to the parish is affected the way the law now exists. If the suggestions for revision, contained in this discussion, are adopted, the revenue accruing to the parish from forest lands will hardly be influenced. There have been several instances where landowners have applied to the police jury for authority to enter into a reforestation contract, but permission has been denied without advancing any good reason other than the effect on parish revenue. It must be admitted, however, that this is a very strong reason since the income to a parish is almost entirely dependent on taxes derived from real property. Admittedly the resident owner of a small tract of land would scarcely be benefitted by the reforestation contract law because he is already enjoying a homestead exemption. The chief beneficiary would probably be the owners of that one-third of all the forest acreage, the Class II lands and the industrial, or Class III forest area. The resident landowners, a very influential part of the voting population and those who hold the balance of power in parish and State politics, would have to be sold on the merits of the proposed revision, viz., increased forest productivity eventually with greater local employment opportunities. (c) All parishes, and particularly the poorer rural ones in which most of the forest conservation districts would be situated, are continually confronted with financial problems. If the privilege of fixing the assessed valuation against forest lands is withdrawn from the parish authorities, then they should be compensated. It is suggested that the parish be subsidized out of severance taxes accruing to the State. This subsidy could be fixed at ten cents per acre per year for all land that has been listed under the Reforestation Contract Law, being paid to the parish affected by the lands listed under the Law. The present reforestation law provides that three-quarters of the sums collected at time of severance be paid to the parish concerned. The parish, however, would probably prefer to have present income than future income. The state is in a much more advantageous position to fund its operations than is the parish. With the gross income to the state from its severance taxes probably increasing rather than decreasing, there should be no great difficulty in paying the parishes from state severance taxes the necessary amount. (d) New Reforestation Contracts should be entered into by the State only on lands included within a Forest Conservation District. Although the Reforestation Contracts would be made between the individual owners and the State, no contract should be entered into unless preceded by an agreement between the landowner and the Forest Conservation District. (e) The revised law should include a provision that all reforestation contracts in existence at the time of enactment of the new law should continue to be valid but that they can be declared invalid if all parties agree, provided that a new contract is entered into between the State and the landowner.

APPENDIX

TABLE A

QUANTITY OF OWNERS OF FOREST LAND
ARRANGED BY CLASSES OF OWNERSHIPS AND PARISHES

FOREST TYPE AND PARISH	CLASS I				CLASS II				CLASS III				TOTALS			
	Resident	Contiguous	Absentee	Totals	Resident	Contiguous	Absentee	Totals	Resident	Contiguous	Absentee	Totals	Resident	Contiguous	Absentee	Totals
DeSoto	1022	602	285	1909	287	599	500	1386	....	5	3	8	1309	1206	788	3303
Jackson	802	250	59	1111	78	314	130	522	....	2	3	5	880	566	192	1638
LaSalle	547	103	21	671	16	314	117	447	....	4	7	11	563	421	145	1129
St. Helena	714	211	44	969	42	180	53	275	....	1	6	7	756	392	103	1251
Union	1474	536	109	2119	84	407	268	759	....	1	4	5	1558	944	381	2883
Shortleaf-Loblolly	4559	1702	518	6779	507	1814	1068	3389	....	13	23	36	5066	3529	1609	10204
Percent	44.68	16.68	5.08	66.43	4.97	17.78	10.47	33.21	....	0.13	0.23	0.35	49.65	34.58	15.77	....
Beauregard	848	137	84	1069	89	574	1024	1687	....	1	8	9	937	712	1116	2765
St. Tammany	684	61	4	749	436	539	314	1289	....	2	17	19	1120	602	335	2057
Longleaf-Slash	1532	198	88	1818	525	1113	1338	2976	....	3	25	28	2057	1314	1451	4822
Percent	31.77	4.11	1.82	37.70	10.89	23.08	27.75	61.72	....	0.06	0.52	05.8	42.66	27.25	20.09	....
Concordia	276	57	26	359	34	24	41	99	....	1	6	7	310	82	73	485
Madison	128	126	42	296	10	72	48	130	....	....	7	7	138	198	97	433
Miss. H'dw'ds	404	183	68	655	44	96	89	229	....	1	13	14	448	280	170	898
Percent	44.99	20.38	7.57	72.94	4.90	10.69	9.91	25.50	....	0.11	1.45	1.56	49.89	31.18	18.93	....
TOTALS	6495	2083	674	9252	1076	3023	2495	6594	....	17	61	78	7571	5123	3230	15924
Percent	40.74	13.08	4.23	58.10	6.76	18.98	15.67	41.41	....	0.11	0.38	0.49	47.54	32.19	20.26	....

TABLE B

AREA HELD BY CLASSES OF OWNERS OF FOREST LAND ARRANGED BY PARISHES

FOREST TYPE AND PARISH	CLASS I				CLASS II				CLASS III				TOTALS			
	Resident	Contiguous	Absentee	Totals	Resident	Contiguous	Absentee	Totals	Resident	Contiguous	Absentee	Totals	Resident	Contiguous	Absentee	Totals
DeSoto	78,432	79,786	47,968	206,537	17,180	40,090	41,831	98,111	....	1,343	26,840	28,183	94,718	121,219	116,639	322,831
Jackson	45,587	32,943	6,004	84,594	4,352	31,325	18,302	54,006	....	55,000	91,080	146,280	49,939	119,469	115,446	301,734
LaSalle	29,528	7,943	835	38,036	1,285	18,433	11,743	31,461	....	126,623	67,214	193,837	30,813	152,999	79,792	263,604
St. Helena	55,162	26,329	10,565	92,056	2,442	20,386	21,168	43,996	....	264	63,050	63,314	57,604	46,979	94,783	199,366
Union	102,975	52,254	15,273	169,502	4,368	30,776	50,613	84,757	....	2,137	168,648	170,785	106,443	85,167	234,534	425,044
Shortleaf-Loblolly	310,784	199,255	80,645	590,995	28,627	141,041	133,657	312,331	....	183,430	416,832	602,399	525,417	525,832	641,194	1,522,579
Percent	20.41	13.00	5.3	38.81	1.88	....	8.78	20.51	....	12.04	27.38	39.56	22.29	34.54	42.11	....
Beauregard	51,870	11,280	5,261	68,413	5,161	56,540	426,078	487,779	....	8,213	117,797	126,010	57,031	76,035	549,136	686,661
St. Tammany	33,465	7,337	141	41,541	18,697	96,268	54,405	166,635	....	48,324	85,172	123,496	52,162	151,929	139,718	331,672
Longleaf-Slash	85,335	18,617	5,402	109,954	23,858	152,808	480,483	654,414	....	56,537	202,969	249,506	109,193	227,964	688,854	1,018,333
Percent	8.38	1.83	0.53	10.80	2.34	15.00	47.18	64.26	....	5.55	19.93	24.50	10.72	22.39	67.74	....
Concordia	62,319	42,762	23,598	128,679	4,963	27,036	65,467	97,466	....	814	77,641	78,455	67,282	70,612	166,706	304,600
Madison	27,539	89,568	27,624	144,731	856	17,719	17,642	36,217	....	....	80,151	80,151	28,395	107,287	125,417	261,099
Miss. H'dw'ds	89,958	132,330	51,222	273,410	5,819	44,755	83,109	133,683	....	814	157,792	158,606	95,677	177,899	292,123	565,699
Percent	15.00	23.39	9.05	48.33	1.03	7.91	14.69	23.62	....	0.14	27.89	28.04	16.44	31.44	51.63	....
TOTALS	485,977	350,202	137,269	974,359	58,304	338,573	707,249	1,100,428	....	240,781	777,593	1,010,511	544,287	931,695	1,622,171	3,085,298
Percentages	15.64	11.27	4.42	31.36	1.88	10.90	22.77	35.42	....	7.72	25.20	32.51	17.52	29.96	52.58	....

TABLE C

SIZE CLASS DISTRIBUTION AND QUANTITY OF OWNERS HOLDING FOREST LAND

SIZE CLASS	PARISH AND FOREST TYPE												
	DeSoto	Jackson	LaSalle	St. Helena	Union	Loblolly-Shortleaf	Beauregard	St. Tammany	Longleaf-Slash	Concordia	Madison	Hardwoods	TOTAL
(1) 1-10.........	190	39	218	52	213	712	253	322	575	37	49	86	1,373
(2) 11-20........	257	94	178	85	433	1,047	335	367	702	54	12	66	1,815
(3) 21-40........	795	382	314	233	745	2,469	827	469	296	87	49	136	3,901
(4) 41-80........	808	435	212	317	712	2,484	613	374	987	76	75	151	3,622
(5) 81-120.......	394	267	82	206	345	1,294	235	150	385	40	35	75	1,754
(6) 121-160......	271	245	57	114	177	864	179	133	312	30	31	61	1,237
(7) 161-320......	318	160	38	152	175	843	162	114	276	48	59	107	1,226
(8) 321-640......	173	49	15	58	67	357	74	55	129	29	69	98	584
(9) 641-1,280....	69	10	3	23	25	130	27	35	62	23	38	61	253
(10) 1,281-2,560..	30	1	5	5	6	47	13	16	29	17	36	53	129
(11) 2,561-5,120..	5	......	1	......	3	9	2	9	11	7	13	20	40
(12) 5,121-11,520.	2	1	......	......	2	5	8	5	13	9	4	13	31
(13) 11,521-23,040	......	1	2	......	1	4	5	......	5	4	3	7	16
(14) 23,041-46,080	1	......	1	1	......	3	2	2	4	2	2	4	11
(15) 46,081-69,120	......	1	......	1	......	2	......	......	0	......	......	0	2
(16) 69,121-Inf....	......	......	1	......	1	2	2	......	2	......	......	0	4
TOTAL....	3,313	1,685	1,127	1,247	2,900	10,272	2,737	2,051	4,788	463	475	938	15,998

TABLE D

SIZE CLASS DISTRIBUTION AND ACREAGE OF FOREST LAND HELD BY OWNERS

SIZE CLASS	PARISH AND FOREST TYPE												
	DeSoto	Jackson	LaSalle	St. Helena	Union	Loblolly-Shortleaf	Beauregard	St. Tammany	Longleaf-Slash	Concordia	Madison	Hardwoods	TOTAL
(1)	1,385	298	1,394	362	1,796	5,235	1,772	2,211	3,983	311	62	373	9,591
(2)	4,103	1,473	3,021	1,156	7,521	17,274	5,395	5,144	10,539	912	192	1,104	28,917
(3)	22,540	11,326	10,047	5,358	25,132	74,403	27,272	13,259	40,531	2,750	1,516	4,266	119,200
(4)	37,600	21,973	13,298	12,993	43,181	129,045	36,638	20,895	56,533	4,618	3,395	8,013	194,591
(5)	26,081	20,807	8,330	15,011	34,435	104,664	21,800	13,277	35,077	4,145	2,368	6,513	146,254
(6)	24,517	26,442	8,668	12,274	24,393	96,294	25,266	18,505	43,771	4,360	3,060	7,420	147,485
(7)	44,473	29,026	8,768	27,758	38,122	148,147	32,656	20,610	53,266	11,574	9,464	21,038	222,451
(8)	47,696	19,210	6,208	22,715	26,977	122,806	31,488	23,160	54,648	12,497	20,211	32,708	210,162
(9)	35,503	8,301	4,561	16,925	21,330	86,620	19,403	32,244	51,647	19,297	23,271	42,568	180,835
(10)	28,553	8,715	15,245	5,779	10,289	68,581	21,543	25,932	47,475	43,012	42,664	85,676	201,732
(11)	16,935	....	4,019	....	9,830	30,784	5,798	43,223	49,021	28,179	30,308	58,487	138,292
(12)	17,034	5,521	....	....	15,006	37,561	69,802	53,262	123,064	66,759	23,140	89,899	250,524
(13)	....	13,588	52,749	....	21,862	88,199	85,765	....	85,765	65,492	34,072	99,564	273,528
(14)	26,406	74,095	45,055	23,745	....	169,301	62,541	59,950	122,491	51,262	67,376	118,638	410,430
(15)	....	58,716	....	56,446	....	115,162	....	....	....	....	....	....	115,162
(16)	....	....	82,241	....	143,803	226,044	235,609	....	235,609	....	....	....	461,653
TOTAL	332,826	299,491	263,604	200,522	423,677	1,520,120	682,748	331,672	1,014,420	315,168	261,099	576,267	3,110,807

TABLE E

LEGAL IDENTITY OF OWNERS OF FOREST LAND

PARISH	INDIVIDUALS				CORPORATIONS		ESTATES		PARTNERSHIPS		TOTALS	
	MEN		WOMEN									
	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area
DeSoto	1,690	138,937	731	49,044	82	69,700	446	37,445	359	63,763	3,308	358,889
Jackson	1,227	104,406	297	19,355	52	156,420	89	14,487	51	7,066	1,716	301,734
LaSalle	689	41,554	209	9,843	20	195,705	160	9,764	39	5,619	1,117	262,485
St. Helena	798	75,859	237	21,169	30	62,518	134	17,072	59	6,716	1,258	183,334
Union	1,915	155,478	447	27,259	59	195,249	294	31,232	160	12,546	2,875	421,764
Loblolly-Shortleaf	6,319	516,234	1,921	126,670	243	679,592	1,123	110,000	668	95,710	10,274	1,528,206
Percent	61.50	33.78	18.70	8.29	2.37	44.47	10.93	7.20	6.50	6.26	....	....
Beauregard	2,029	181,528	421	25,752	51	451,624	90	7,277	155	23,759	2,746	689,940
St. Tammany	1,426	117,108	418	21,933	73	157,658	71	16,850	66	20,480	2,054	334,029
Longleaf-Slash	3,455	298,636	839	47,685	124	609,282	161	24,127	221	44,239	4,800	1,023,969
Percent	71.98	29.16	17.48	4.66	2.58	59.50	3.35	2.36	4.60	4.32	....	....
Concordia	306	98,193	60	24,564	29	110,689	40	17,348	27	54,320	462	305,114
Madison	283	79,117	53	19,088	32	129,960	15	4,695	52	28,239	435	261,099
Bottomland Hardwoods	589	177,310	113	43,652	61	240,649	55	22,043	79	82,559	897	566,213
Percent	65.66	31.32	12.60	7.71	6.80	42.50	6.13	3.89	8.81	14,58	....	....
TOTAL	10,363	992,180	2,873	218,007	428	1,529,523	1,339	156,170	968	222,508	15,971	3,118,388
Percent	64.89	31.82	17.99	6.99	2.68	49.05	8.38	5.01	6.06	7.14	....	....

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WARTIME PRODUCTION AND TRANSPORTATION OF MILK IN THE SHREVEPORT AREA OF LOUISIANA

By

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WARTIME PRODUCTION AND TRANSPORTATION OF MILK IN THE SHREVEPORT AREA OF LOUISIANA

By

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INTRODUCTION

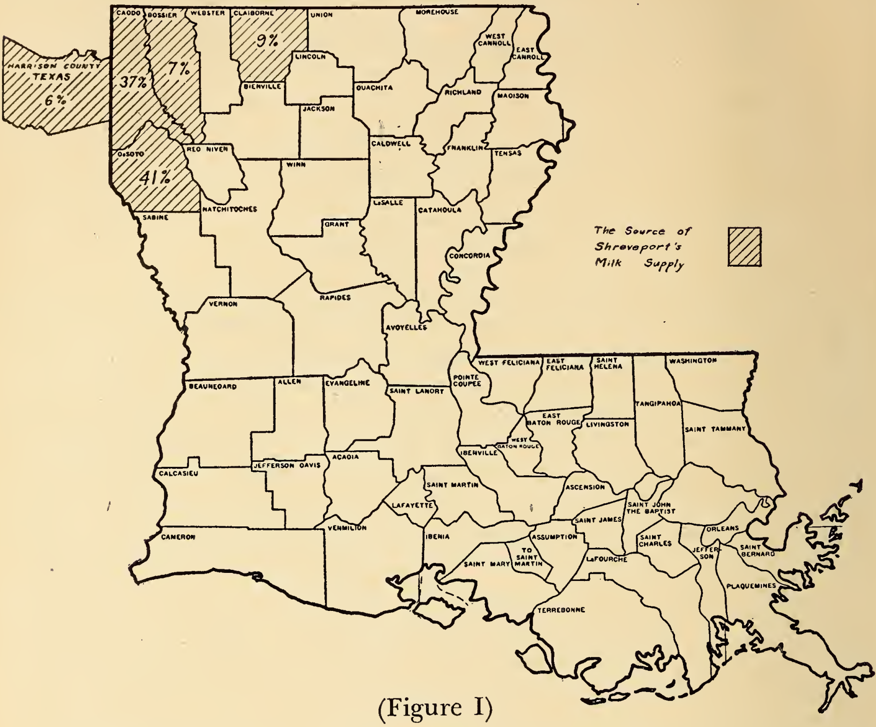
Whole milk ranks high as a human food from the standpoint of nutrition and health. During the war emergency, the production of milk and other dairy products is important not only for our domestic needs, but also to help feed our allies. For these reasons, it is especially important to increase the supply and maintain the delivery of milk to both civilian and military consumers, in spite of less favorable margins between cost of production and the price received by farmers and dwindling facilities for transporting milk from the farms to concentration points. Shortage of tires, gasoline, truck equipment, and man power makes it urgent that the concentration system be efficiently organized.

This study has to do with milk transportation in the area around Shreveport, Louisiana, and its main purpose is to determine how milk might be more efficiently hauled from farm to the distribution center at Shreveport. Consideration is given to methods by which reductions may be made in the number of trucks and truck operators needed, gasoline consumed, and miles of tire use. Also, some attention is given to changes in feed and labor costs, since these factors relate to sustained milk production. During the progress of the study, some changes toward greater efficiency were made and the recommendations point the way to further reorganization of milk-hauling methods which should be helpful to producers in maintaining an adequate concentration system. These matters are all vital to the war effort, since the supply of new trucks will not be adequate to meet the transportation needs unless supplemented by the strictest conservation of the existing supply.

The information presented in this manuscript was obtained by personal interview with 155 dairy farmers who produce the milk sold in Shreveport. Additional information was obtained from the Caddo Parish Health Unit, Dr. E. B. Hand, formerly head of the "Milk Testing Fund," feed dealers, and milk truck operators.

Location and Size of Dairy Business in the Shreveport Area

Ninety-four percent of the wholesale raw milk sold in Shreveport is produced by dairy farmers in Bossier, Caddo, Claiborne, and DeSoto parishes in Louisiana, and six percent is produced in Harrison County, Texas (Figure 1). Seventy-eight percent of the dairy farmers in the milkshed are located in Caddo and DeSoto parishes.



(Figure I)

In April, 1943, there were 142 dairy farmers in the Shreveport milk shed who produced wholesale raw milk. This represents an increase of fourteen producers over the same month in 1942. Also there was an increase in the number of cows in the herds (table 1). The increase in

TABLE 1. THE NUMBER OF DAIRY FARMERS, COWS IN HERD AND TOTAL MILK PRODUCTION FOR THE SHREVEPORT MARKET APRIL, 1942 AND APRIL, 1943

PARISH	NUMBER DAIRY FARMERS IN APRIL		NUMBER DAIRY COWS IN APRIL		TOTAL POUNDS OF MILK MARKETED IN APRIL	
	1942	1943	1942	1943	1942	1943
Bossier	9	10	613	630	168,376	161,525
Caddo	40	45	2,667	3,301	723,344	913,763
Claiborne	17	17	658	711	199,135	216,402
DeSoto	52	60	3,219	3,649	867,619	998,067
Harrison	10	10	574	654	128,077	152,499
TOTAL	128	142	7,731	8,945	2,086,551	2,442,256
Increase over 1942	..	14	......	1,214	....	355,705

volume of milk sold in April, 1943, over the same month in 1942 reflects the increase in the number of cows and a greater average production per cow. The increase in the number of cows per herd and number milked, probably results from fewer old cows being culled out and more young cows kept for milking.

Fifty-seven percent of the cows in the herds in April, 1943, were being milked, which indicates that a high percentage of cows were bred to freshen in the spring and summer. Considerable advancement would result from improved herd management, whereby more of the cows freshened in the fall of the year when milk production is lower.

The average dairy herd in the Shreveport milkshed is considerably larger than dairy herds in the Kentwood area, in the New Orleans milkshed. The average size dairy herd in the Kentwood area in 1938 was thirty-seven cows per herd of which an average twenty-one were milked.[1]

In April, 1943, there was an average of sixty-three cows in the herd of which an average of thirty-six were milked in the Shreveport area (table 2).

TABLE 2. THE NUMBER OF COWS IN THE HERD, NUMBER MILKED AND THE PRODUCTION PER COW IN THE SHREVEPORT MILK SHED APRIL, 1942 AND APRIL, 1943

PARISH	AVERAGE NUMBER COWS IN HERD IN APRIL		AVERAGE NUMBER OF COWS MILKED PER HERD IN APRIL		AVERAGE PRODUCTION PER COW MILKED IN APRIL	
	1942	1943	1942	1943	1942	1943
					Pounds	*Pounds*
Bossier	51	63	40	43	423	372
Caddo	59	73	33	41	483	499
Claiborne	39	42	23	25	516	513
DeSoto	54	61	31	34	472	485
Harrison	57	65	32	40	403	378
AREA AV.	58	63	34	36	470	475

Probably the main reason that herds are considerably larger in the Shreveport milkshed is that dairy farmers in that area are in the dairy business because they choose to produce milk rather than cotton or other farm crops. Also the area surrounding Shreveport is probably more adapted to production of pastures and hay crops than the soil and topography in the Kentwood area.

Number and Types of Routes

In the Shreveport milkshed there were eighteen wholesale raw milk routes hauling milk from farms to dealers in April, 1943. Five routes served only two producers, three served three producers, and three served four producers. There were only seven routes serving more than four producers.

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[1] Efferson, J. N. and Merrick, Frank, *An Economic Study of Dairy Farms in the Kentwood Area of Southeastern Louisiana,* Louisiana Bulletin No. 325, p. 6, Baton Rouge, June, 1940.

The average route was twenty-three miles long, of which one-half mile was dirt road, one mile of gravel, and slightly over twenty miles of pavement.

The average charge for hauling milk was twenty cents per hundredweight.

Condition of Trucks

In April, 1943 the age of trucks operating in the Shreveport milkshed ranged from six months to ten years. Sixty percent of the trucks had been used three or more years (table 3). This is significant, because trucks beyond three years of age require frequent replacement of parts in order to continue operation. The supply of new trucks will not be adequate to meet the needs for milk hauling; therefore, more stringent conservation of the existing supply should be enforced by periodic "check ups" with mechanics and proper parts installed. Dependable truck transportation is necessary in order to move milk from farms to dealers at least once per day if it is to be of use to consumers. Failure of truck transportation for individuals or route haulers for one day would mean that the production for the individual or number of individuals on the route concerned is wasted. Trucks must be continuously available as well as in good operating condition to prevent serious delay in getting milk to the market.

TABLE 3. AGE OF TRUCKS IN SHREVEPORT MILKSHED APRIL, 1943

AGE OF TRUCKS	Number of trucks	Per cent of total	Cumulative per cent
(Years)			
0.5 to 1.49	2	3.00	3.00
1.5 to 2.99	12	18.00	21.00
3.0 to 4.49	26	39.00	60.00
4.5 to 5.99	9	13.00	73.00
6.0 to 7.49	12	18.00	91.00
7.5 to 8.99	2	3.00	94.00
9.0 to 10.49	3	4.00	98.00
10.5 or over	1	2.00	100.00
TOTAL	67	100.00	......

The rated capacity of trucks is an important factor to consider when proposing route organization. In April, 1943, 58 percent of all trucks used in milk delivery in the Shreveport milkshed had rated capacity of 1,000 pounds. Approximately one-fourth of the trucks had rated capacity of one or more tons.

The first step in the organization of a route is to locate a truck large enough to haul all the milk on the proposed route, even in the period of peak production. It would be necessary for ration officials, producers, milk dealers, and truck operators to agree on the size of truck, time of delivery and the rate charged for delivery before a successful program of route organization could be instituted. The information in Table IV should serve as a guide to any agency allotting permits to purchase new trucks, as one large truck operating on an organized route could replace the service of three or more smaller trucks.

TABLE 4. SIZE OF TRUCKS IN SHREVEPORT MILKSHED APRIL, 1943

SIZE OF TRUCK (*tons*)	Bossier	Caddo	Claiborne	DeSoto	Harrison Co., Tex	TOTAL
1/2	5	19	0	13	2	39
3/4	3	2	0	2	3	10
1	0	3	0	0	0	3
1 1/2	0	2	2	4	0	8
Other	0	3	0	2	2	7
TOTAL	8	29	2	21	7	67

Table 5 indicates the miles of use of tires on milk delivery trucks of dairy farmers in the Shreveport milkshed in April, 1943. Forty-eight percent of the tires had been used more than 20,000 miles. Fifty-one tires or 17 percent had been used less than 5,000 miles in April, which is an indication that the dairymen had been drawing heavily on the reserve of tires allotted to their respective parishes late in 1942 and early

TABLE 5. MILES OF USE OF TIRES ON MILK TRUCKS OPERATING IN THE SHREVEPORT MILKSHED IN APRIL, 1943

MILES TRAVELED	Number of tires	Per cent of total	Cumulative Per cent
(*Thousand miles*)			
0. to 4.99	51	17.71	17.71
5.0 to 9.99	42	14.58	32.29
10.0 to 14.99	43	14.93	47.22
15.0 to 19.99	15	5.21	52.43
20.0 to 24.99	31	10.76	63.19
25.0 to 29.99	16	5.56	68.75
30.0 to 34.99	24	8.33	77.08
35.0 to 39.99	9	3.13	80.21
40.0 to 44.99	23	7.98	88.19
45.0 to 49.99	12	4.17	92.36
50.0 or over	22	7.64	100.00
TOTAL	288	100.00	......

1943. The so called "war tire" is reported to be less durable than pre-war tires; therefore, the required number for operation of the fleet of trucks will be larger in 1944-45. The elimination of unnecessary trucks and superfluous mileage on present routes would result in considerable conservation of tires and trucks. Normally it is estimated that the life of tires on milk trucks is approximately 30,000 miles. With 31 percent of the tires having over 30,000 miles on them it is obvious that the replacements needed will greatly exceed the normal number. The range in mileage on tires was less than 4,000 miles to over 50,000 miles. The large number of tires in higher mileage brackets appear to be due to several factors among which were: (1) better care of tires on the part of truck operators, i.e., proper inflation, etc., (2) delay in official action for a permit to secure a new tire, and (3) use of recapped tires to extend the use of tires beyond normally expected mileage.

The conservation of the present tires is of utmost importance. The rationing of tires to insure equal distribution has made it necessary for ration officials to set up quotas for each parish; therefore, it is difficult to secure a tire when needed. Tires will be increasingly difficult to obtain in 1944-45 if present hostilities do not cease.

The Utilization of Trucks

Some of the trucks being used in transporting milk from farms to market are not efficiently utilized, especially those serving only one producer per truck. Forty-nine trucks or 73 percent of the total number serve only one producer. These trucks utilized only 68 percent of the total rated capacity in April, 1943, which is near the period of peak production for the year; therefore, it is probable that less efficiency of capacity utilization existed during months of lower production. One of the trucks in this group was operated by a milk plant. This truck went out 11 miles each day to pick up milk from one producer who did not have adequate transportation facilities. In making this trip, 9 dairy farmers' houses were passed on the way out to the individual producer's. Seven of the 9 producers delivered only their individual production to the same milk plant operating the truck. This truck could also adequately serve the other seven producers who deliver milk to the plant, thus eliminating seven trucks from daily operation. This would result in saving approximately 140 miles per day or 4,200 miles per month.

While it is true that some of the producers who haul only their individual production are necessary because no route or other trucker passes his farm, it is likewise true that if routes were organized in the area, many trucks could be held in reserve for later use.

There were 5 dairy farmers who were hauling milk for themselves and one other or a total of 2 producers per truck (table 6). They were utilizing 89 percent of the rated capacity of their trucks in April, 1943.

Three trucks were being used by 3 dairy farmers each and three trucks were serving 4 producers each, utilizing 94 and 96 percent of their rated capacity respectively.

TABLE 6. The Number of Producers Served Per Truck, Rated Capacity of Trucks, Pounds of Milk Hauled Per Day Per Truck, Miles Traveled Per Day and Pounds of Milk Per Mile of Travel in the Shreveport Milkshed in April, 1943

Number of trucks	Number of producers served per truck	Per cent of truck	Total rated capacity of trucks	Total pounds of milk hauled per day	Average pounds of milk per truck	Per cent of total rated capacity utilized	Total miles per day	Pounds of of milk per mile of travel
49*	1	73	57,000	38,828	792	68	1,281	30
5	2	8	6,000	5,316	1,063	89	167	32
3	3	4	6,000	5,630	1,877	94	63	89
3	4	4	7,000	6,705	2,235	96	128	52
1	6	2	3,000	2,217	2,217	74	140	16
2	8	3	6,000	5,096	2,548	85	107	48
3	9	4	8,000	12,618	4,206	158	202	62
1	11	2	3,000	4,998	4,998	167	190	26
Total 67	XX	100.0	96,000	81,408	XX	XX	2,278	XX

*Three other type vehicles included.

One truck serving 6 producers made one trip daily from Claiborne Parish, utilizing 74 percent rated capacity.

Three trucks serving 9 producers each were in operation prior to the time the study was begun. These trucks were utilizing 158 percent of their rated capacity in April, 1943. This means that they were 58 percent overloaded, which is poor economy on tires either in normal times or in times of war.

The greatest number of producers served by any one truck was eleven. This truck had the greatest total daily mileage of any truck in operation in the Shreveport milkshed. It served producers in the north central section of Claiborne Parish and had a round trip mileage of 190 miles per day. It operated at 67 percent above its rated capacity in April, 1943.

The 18 trucks hauling for two or more dairy farmers each were considered as route trucks or commercial haulers. Table 7 shows the amount of milk hauled by commercial haulers and the amount hauled by the individual producer, commonly known as "self-haulers." The greatest

TABLE 7. The Volume of Milk Hauled by Commercial and Self-Haulers in the Shreveport Milkshed, April, 1943

TYPE OF HAULER	Bossier	Caddo	Claiborne	DeSoto	Harrison Co., Tex.	TOTAL	Per cent of total
Commercial.........	18,285	312,333	216,402	615,636	73,972	1,236,628	50.63
Self................	136,094	497,895	None	312,877	78,527	1,025,393	41.99
Other..............	7,146	103,535	None	69,554	None	180,235	7.38
TOTAL....	161,525	913,763	216,402	998,067	152,499	2,442,256	100.00

percentage of milk hauled by self-haulers was in Bossier Parish. This may be partially explained by the fact that dairy farmers nearer the market usually deliver their production. Also the lack of concentration of producers within a community or along the same highway may make it necessary for individual dairy farmers to haul only their own production to market. However, it is recommended that at least one route be organized in Bossier Parish. This would eliminate 3 trucks from daily operation over the same road and reduce the number of miles traveled by 51 miles per day or 1,530 miles per month. Caddo Parish ranks second in the number of self-haulers with fifty-four percent of the total milk supply hauled by this group in April, 1943.

Thirty-five percent of the dairy farmers delivered their own milk to dealers in Shreveport and produced 42 percent of the total supply in April, 1943. They did not haul milk for other farmers and their 49 trucks constituted 73 percent of all trucks used. They utilized only 68 percent of the rated capacity of their trucks, while trucks on commercial routes utilized an average of 117 percent of their rated capacity.

The study revealed the need for cooperation among the interested groups in order to formulate new routes and reorganize existing ones in order to reduce the number of self-haulers to a minimum.

Route Organization

The need for route organization becomes evident when it is noted that there were only six trucks that hauled for more than six dairy farmers in the Shreveport milkshed in April, 1943. There are a number of benefits to dairy farmers who send their milk to market on private or commercially operated routes. The first and paramount benefit would be the elimination of waste of trucking equipment, tires, and gasoline. Numerous hours of man power required for each to individually market his production would be conserved and more time could be given to efficiently operating the dairy farm or to some other enterprise. If full capacity of trucks is utilized there is less cost per unit than if capacity is only 50 to 60 percent utilized. Therefore, route organization, for the purpose of consolidating a number of producers in the same community or along an established route into one route instead of each producer hauling his individual production, would reduce the marketing cost to the dairy farmer and thus increase his net income.

Route organization would help to solve the problem of congestion of trucks at milk plants during the unloading period. This problem alone caused considerable loss to dairy farmers in the Shreveport milkshed in the summer months of 1943. It was reported that at times during the summer, individual trucks, and in some instances, route trucks were required to stand in the sun from 1 to 3 hours daily. This caused milk to spoil or sour; therefore, it was not acceptable to the dealer.

The dealers in the Shreveport area were not too enthusiastic to aid in forming routes for the farmers. Route organization would benefit the dealers in a number of ways: (1) aid in regulating the flow of milk to plants so that vats are not kept idle for any period of time or trucks are not made to wait while vats are being pasteurized or emptied, (2) insure the dealer of approximately the same volume of milk seasonally, (3) trucks could be staggered in order to prevent congestion at the plant, (4) milk will reach the plant in better condition because delay in the sun would be prevented.

Route organization would also give the commercial hauler an incentive to offer better service in order to maintain the volume of milk hauled. The routes operated in the Shreveport milkshed in April, 1943, were organized by private individuals who were primarily interested in sufficient volume of milk to make the operation of a truck profitable. Few producers have tried to organize routes, but were unsuccessful. The producers reason for not cooperating in the route formation was that they have to go to "town" anyway; so why not haul their own milk. This attitude may be acceptable in normal peace-time even though it cost more to deliver small quantities of milk, but during war-time when trucks, tires, and gasoline are vital to the war effort, some compulsion should be exercised to reduce the unnecessary mileage of individual producers because of psychic values to them.

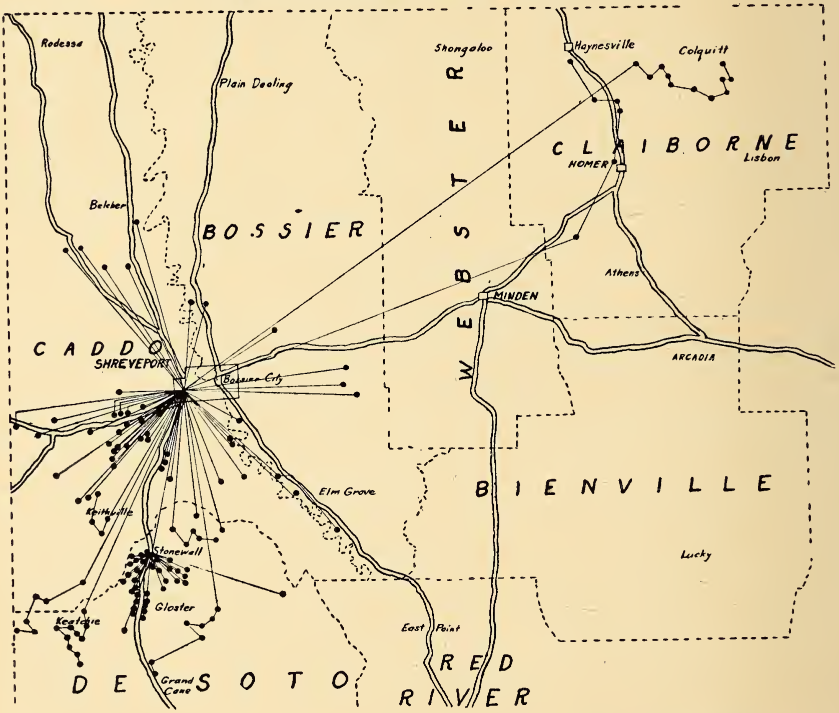
Twenty-seven producers delivered milk daily to a receiving and cooling station at Stonewall, Louisiana, while 115 producers sold milk to Shreveport. The cooling station has been an effective means of concentrating milk to be delivered to market. Also it has been beneficial to producers in reducing the number of home milk cooling units required in the immediate vicinity of Stonewall. The producers who deliver to the cooling station deliver milk twice daily. There were two routes hauling milk to the cooling station in April, 1943, one serving eight producers and one cooperative serving four producers. Each producer on the cooperative route hauled milk for the other producers one week out of each month. Thirteen producers hauled only their individual production to the station. The receiving station handled 278,889 pounds of milk or 11.4 percent of the wholesale raw milk marketed in Shreveport in April, 1943. Fifteen trucks delivered milk to the receiving station and 52 of the 67 trucks operating in the milkshed hauled milk directly to the market in Shreveport. The trucks delivering milk to Stonewall represent 27 percent of the trucks operated and accounted for 7 percent of the total miles traveled per day in the Shreveport milkshed in April, 1943.

Figure 2 indicates the location of producers and the routes operated in the Shreveport milkshed in April, 1943. The dots connected by lines show the routes, and lines directly to the market point indicate that the producer delivers only his individual production to the plant. There are 67 lines leading to marketing points showing how the milk reached the market in April, 1943.

Figure 3 represents a revision of Figure 2 and indicates the organization of eight new routes and thus eliminates 28 trucks from daily operation to the market. These trucks may be held in reserve for future use. Also, this would eliminate 687 miles of truck and tire use per day or 20,610 miles per month. This would reduce the tire requirement by approximately 24 tires in 1944, assuming that each tire could be used 10,000 miles or more. No attempt has been made in this report to formulate routes for those producers who live less than five miles from the market.

This organization of routes would inconvenience some producers, but the benefits derived would more than offset the difficulties incurred.

Figure II The location of wholesale raw milk producers and existing routes in the Shreveport milk shed April, 1843



FACTORS RELATING TO SUSTAINED MILK PRODUCTION

The Feed Situation

Probably the problem of most concern in the Shreveport milkshed is the inadequate feed supply for 1944-45. It has been necessary for the producers to change their analysis or brand of feed frequently due to dealers inability to supply all the producers with their favorite type of feed. This inability has been one big factor in the number of miles traveled by producers because they are compelled to make two or three trips in order to obtain the feed desired. Additional difficulties were encountered due to the shortage of labor needed in saving home grown feed. In some instances farmers were forced to graze their forage crops instead of harvesting them.

Roughly speaking, feed purchases represent 50 percent of the cash cost of producing milk. Table 8 shows the indices of twelve main brands of dairy feed used by dairy farmers in the Shreveport milkshed from January, 1941, through March, 1943. The price paid in January, 1941, equals 100. Note from the indices that feed prices have continually advanced from January, 1941, with the greatest increases in 1943.

Figure III The location of wholesale raw milk producers and the proposed route organization in the Shreveport milk shed.

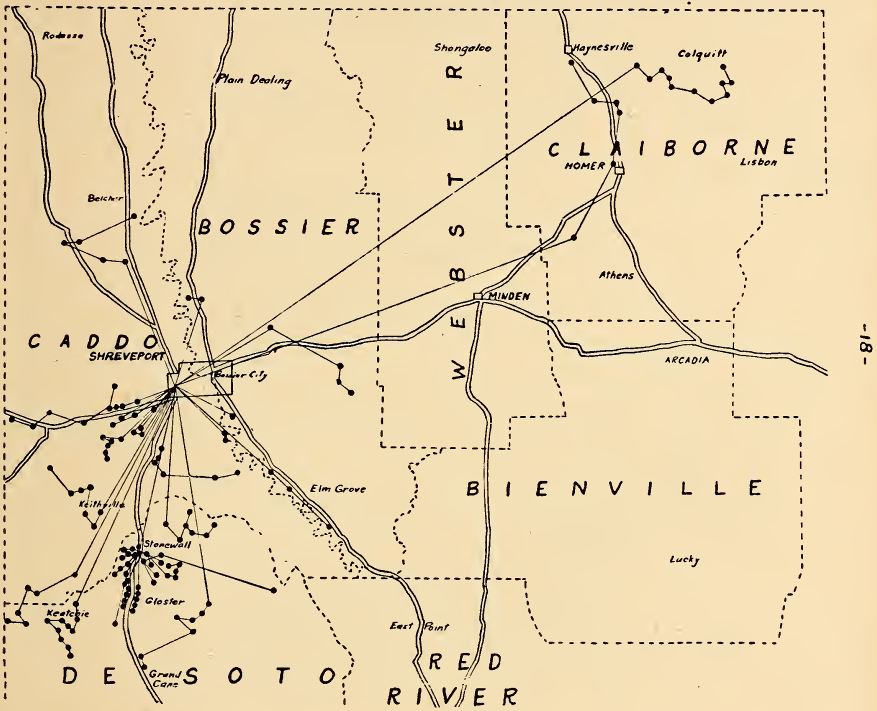


Figure 4 indicates the trend of local retail prices for cottonseed meal, corn meal, 16 percent protein dairy feed, and all feeds from January, 1941, through March, 1943, in the farming area surrounding Shreveport, Louisiana. From January, 1941, to April, 1943, the prices paid by dairy farmers for all concentrated dairy feeds increased 63 percent.

From April to October, 1942, there was a leveling off, and in some cases a slight decline, in prices paid for feed. Normally, feed grain prices de-

TABLE 8. The Index of Prices Paid by Dairy Farmers for the Twelve Most Commonly Used Feeds From January, 1941 Through March, 1943

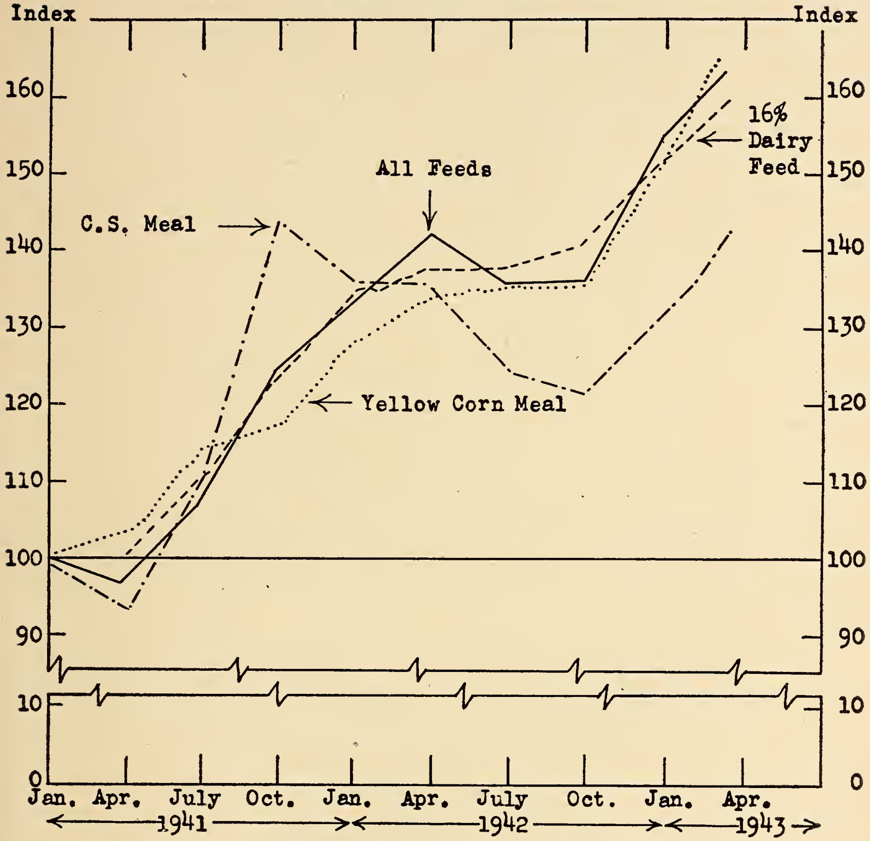
(January, 1941 = 100)

Feeds	Jan. 15 1941	April 15 1941	July 15 1941	Oct. 15 1941	Jan. 15 1942	April 15 1942	July 15 1942	Oct. 15 1942	Jan. 15 1943	Apr. 15 1943
24% Dairy Feed	100	94	106	124	135	132	126	126	141	147
16% Dairy Feed	100	100	110	124	134	138	138	141	152	159
9% Dairy Feed	100	104	117	135	152	143	143	157	165	0*
Hominy	100	100	104	121	138	138	138	142	158	175
Corn Bran	100	100	104	121	133	138	138	138	146	167
Ground Oats	100	97	103	124	145	141	138	138	162	176
Cottonseed Meal	100	94	109	144	134	134	125	122	131	141
Cottonseed Hulls	100	86	79	107	107	114	107	107	0*	0*
Yellow Unbolted Meal	100	103	114	117	128	134	138	138	152	166
Wheat Bran	100	100	104	123	131	158	154	138	161	169
Rice Bran	100	95	0*	0*	120	170	0*	140	165	0*
Wheat Shorts	100	100	130	130	141	163	159	148	159	167
Per cent of January, 1941	...	97	107	125	133	142	136	136	154	163

*No sales reported.

Figure 4. - The index of prices paid by dairy farmers in the Shreveport area for the three most commonly used feeds and for all feeds from January 1941 through March 1943.

(January 1941 = 100)



cline after harvest in the late spring and early summer, and rise during the fall and winter. Cost of storage is one of the main factors causing a rise in price during the late fall and winter months. Also the pattern of feed-grain price fluctuation reflects seasonal variations in consumption and outlook reports on the new crop.

The War Food Administration on October 7, 1943 set up tentative plans for feed processors, mixers, dealers, and farmers to follow in distributing and utilizing available feed supplies. The purpose of these plans was to obtain maximum amounts of meat, milk and other farm products. The recommendations by the W.F.A. for dairy cattle feed were that sufficient feed be produced and mixed to maintain milk production at not less than 1942-43 level.[1]

Ninety-six percent of the milk producers in the Shreveport area bought all the concentrated feed used during April, 1943. The survey indicates there will be about 10 percent more dairy cows to be fed during 1944 than there were in 1943. The supply of local feed produced in 1943 is slightly lower than the production in 1942, due largely to a summer drouth and insufficient labor to harvest some of the feed produced.

The strong demand for feed resulting from an increased number of livestock and more favorable prices for dairy products may cause the price of concentrated feed to rise to a point where feeding practices in the Shreveport area will need to be modified, and pastures and home grown feeds be used more intensively. Pastures and home grown feeds alone cannot be relied upon to maintain the desired production; nevertheless, a more intensive use of them would reduce the amount of concentrates needed and likewise tend to reduce the cost of production. Table 9 shows that the concentrate feed cost per herd has increased 48 percent in April, 1943, as compared to the same period in 1942. The concentrate feed cost per 100 pounds of milk produced is up 40 percent in 1943 over 1942. The difference between the percentage increase of feed cost per herd and the percentage increase per 100 pounds of milk produced is due to the 17 percent increase in the average amount of milk produced per herd in April, 1943, as compared to April, 1942. As indicated by Table 9, 107 of the 128 producers in 1942 reported feed cost figures and amount of milk produced, while 125 producers out of 142 producers reported cost and production figures for the same period in 1943.

The average concentrate feed cost per cow in the herd in the Shreveport area was $3.84 in April, 1942, as compared to $5.57 in April, 1943.

The average pounds of milk produced per cow in the herd in the month of April, 1942, was 273 pounds, as compared to 277 pounds of milk per cow in April, 1943.

Price and Subsidy Situation

The base price paid for wholesale raw milk ranged from $3.00 per hundred weight in January, 1942, to $3.50 in April, 1943. In June, 1943, the rate increased to $3.75 per hundred weight.

During the period from April 20, through July 20, 1942, dairy farmers in the Shreveport milkshed sold a portion of their production as "surplus" milk at a base price of $2.50 per hundred weight. The percentage of an individual's production to be sold as "surplus" was calculated from his winter base, or in other words, all the milk he sold above his average monthly winter sales was sold as "surplus" milk during this period. In this way each dairy farmer has a different base according to his winter

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[1] "The Feed Situation," Bureau of Agricultural Economics, United States Department of Agriculture, Washington, D. C., October, 1943, p. 7.

TABLE 9. CONCENTRATE FEED COST PER 100 POUNDS OF MILK PRODUCED, SHREVEPORT MILKSHED, APRIL, 1943

PARISH	NUMBER OF PRODUCERS REPORTING FEED COST		NUMBER OF COWS PER HERD		CONCENTRATE FEED COST PER HERD		NUMBER POUNDS OF MILK PRODUCED PER HERD		CONCENTRATE FEED COST PER 100 POUNDS OF MILK PRODUCED	
	1942	1943	1942	1943	1942	1943	1942	1943	1942	1943
					(Dollars)	*(Dollars)*			*(Dollars)*	*(Dollars)*
Bossier	6	7	81	71	237.08	379.29	22,295	18,968	1.06	2.00
Caddo	35	41	66	70	260.50	400.47	18,728	20,582	1.39	1.95
Claiborne	14	15	40	42	194.49	299.81	11,828	13,140	1.64	2.28
DeSoto	42	52	60	58	209.11	262.08	17,007	16,090	1.23	1.63
Harrison	10	10	57	65	227.30	332.44	12,808	15,250	2.50	3.03
TOTAL	107	125	XX	XX	XX	XX	XX	XX	XX	XX
Area Av.	XX	XX	60	61	225.70	334.82	16,533	16,806	1.56	2.18

sales. The total amount of milk sold "surplus free" depends on the average monthly sales during the winter months; therefore, if cows were bred so as to freshen in the fall and winter months, this would cause a greater amount of milk to be sold at normal base price, and thus increase the total annual income received from milk. However, there was no "surplus" milk reported in the Shreveport area in 1943.

In an effort to maintain and increase production of fluid milk in all states in the amounts required by the armed forces and civilians, the War Food Administration, through Commodity Credit Corporation, makes "dairy feed adjustment payments" to producers who sell fluid milk. These payments are made in addition to the price paid by purchase of wholesale or retail milk. The payments in the Shreveport milkshed are at the rate of 50 cents per hundred pounds of milk, and/or six cents a pound for butter fat produced.

The rate of payment varied in different parishes in the state; the bases for determining the rate of payment in all parishes were: (1) change in the price of dairy feed since September, 1942; (2) average proportion of dairy feed purchased off the farm; (3) the amount of rainfall in 1943.

However, early in 1944 the rate of payment was made uniform throughout the state at 60 cents per hundred weight. How long the payments will be made depends on legislation with regards to the subsidy program.

Butterfat Tests

The variation in butterfat tests are of great concern to the producers and was reported by some of them to be the variable factor used to manipulate the price received per hundred pounds of milk. For instance, if producers were given an increase of twenty cents per hundred weight in the price of milk by the Office of Price Administration, a reduction of four points in the butterfat test would take away the producer's equity in the higher price entirely. More than half of the dairy farmers interviewed complained about butterfat tests being "too low." The feelings of the farmer may be entirely contrary to fact, but as long as he has no check on tests made by the dealer, he is likely to continue to have such feelings.

The producer markets his milk on the basis of volume and percentage butterfat test. Therefore, it appears that if some agency not concerned with either the purchase or sale of milk were to do the testing or make checks at frequent intervals, it would result in better relations between dealers and dairy farmers.

Dairy Farmer Organization

The dairy farmers in the Shreveport milkshed are handicapped by the absence of any type of organization where producers may meet and discuss problems that affect the group.

In April, 1943, some dairy farmers were getting the kind and amount of feed they needed; others were having difficulty in getting enough feed for a balanced ration. A few dairy farmers were having difficulty selling registered male calves; others needed male calves.

The problem of transporting milk might have been solved more easily by group action within an organization of this kind. The bargaining power of a group is more influential with milk and feed dealers than the action of an individual or an isolated community of producers. These are some of the problems that may be solved by group action or at group meetings of the producers. Because dairy farmers in the Shreveport area have mutual problems, it appears evident that more concerted action would result from organized effort of producers through a dairy farmer organization. It would be the duty of the organization to sponsor programs in the interest of dairy farmers, and oppose any issue that might be detrimental to the group.

SUMMARY

1. In the Shreveport milkshed, the number of dairy herds increased from 128 to 142 during the year ending in April, 1943. During the year the average number of cows per herd increased from 58 to 63, and the number of cows milked from 34 to 36.
2. Four parishes in Northwest Louisiana produced approximately 94 percent of the milk consumed in Shreveport during April, 1943, and six percent was produced in Harrison County, Texas.
3. There were 67 motor vehicles transporting wholesale raw milk from farms to dealers in April, 1943. Eighteen of these were trucks used on milk routes. On eleven of the milk hauling routes, there were less than six producers per route.
4. Sixty-five percent of the trucks had been in use for more than 3 years, and 31 percent of the tires had been used in excess of 30,000 miles.
5. Forty-nine self-haulers were utilizing only 68 percent of their rated truck capacity during the period of peak production.
6. The retail price paid for all feeds purchased in the Shreveport area increased 63 percent from January, 1941, to April, 1943. Also dairymen were handicapped by an irregular supply of commercial feeds.
7. The base price of milk increased approximately 17 percent from April, 1942, to April, 1943.
8. The study shows that facilities used for transporting milk from farms in the Shreveport area to concentration points could be more efficiently utilized. Most of the inefficiency is among the "self-haulers" whose 49 trucks are loaded to only 68 percent of their rated capacity even in periods of peak production. Fewer trucks could deliver the present farm production of milk to market, thus holding in reserve replacements to fill the gap when some trucks are worn out.
9. When the present trucking equipment is worn out, the number of available new trucks will be indequate to replace them until a few

months after Germany is defeated. In view of this fact, it is clear that producers, dealers and haulers would benefit from a coordinated effort to reduce the number of miles traveled daily in concentrating the milk. This may be accomplished by sponsoring a program of route organization or cooperative hauling. In some instances producers may be required to change dealers, but this would be a "balancing out" process and the amount of milk usually received by each dealer would not be materially changed.

RECOMMENDATIONS

1. The organization of 8 routes in addition to the 18 commercial routes is recommended. This would eliminate 28 trucks used by self-haulers and reduce the total mileage traveled per month by 20,610 miles and save 40 percent of the present daily miles of truck and tire use. It would result in the conservation of trucks, tires, gasoline, and manpower which is vital to the war effort.
2. Owners should take their trucks to competent mechanics for periodic "check-up" in order to lengthen the life of the existing facilities.
3. Since farmers sell milk on the basis of volume and butterfat test, some public agency should weigh and test all milk sold, thus benefiting producers, dealers, and consumers.
4. In order that a greater total volume of milk may be sold at the normal base price, and less milk sold at the surplus base price, the practice of having more cows freshen in the fall and winter months would be of benefit to the dairy farmers.
5. The dairy farmers would also benefit from uniting in a producer's organization. The purpose of this organization would be to support programs for improving the status of the producers and to oppose practices that appear harmful to the group.

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RICE YIELDS IN ROOT ROT AREAS IMPROVED BY APPLICATION OF FERTILIZER

By

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RICE YIELDS IN ROOT ROT AREAS IMPROVED BY APPLICATION OF FERTILIZER[1]

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INTRODUCTION

In the rice district of Southwest Louisiana there are numerous areas where rice does not grow satisfactorily. These are usually poorly drained in comparison with adjoining areas, the rice in them is not thrifty, and yields are usually low. They are locally known as root rot areas, or alkali spots.

In 1939, work was started to determine if the yields in these areas could be improved profitably by the application of fertilizer. Several reports on the progress of this work have been published (1), (2), (4). Because of the great need for increased rice production at the present time, the results of these studies are brought together in this bulletin.

SYMPTOMS

The symptoms of root rot are usually first noticed in the latter part of May and early June. The plants are yellow, stunted, and in most cases plentifully covered with the circular brown spots caused by *Helminthosporium oryzae*. The most characteristic symptom is a rotting of the roots (Fig. 1). When severely affected, the plants can be easily pulled from the ground. Badly affected plants produce small heads with relatively few grains.

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[1] Cooperative investigations of the Louisiana Agricultural Experimental Station, the Bureau of Entomology and Plant Quarantine, and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture. This work was initiated in 1939 by T. C. Ryker and W. A. Douglas.

[2] The authors wish to express their appreciation for the fine cooperative spirit and assistance of the farmers in the experiments. They also wish to asknowledge the help of the Rice Experiment Station, Crowley, La.

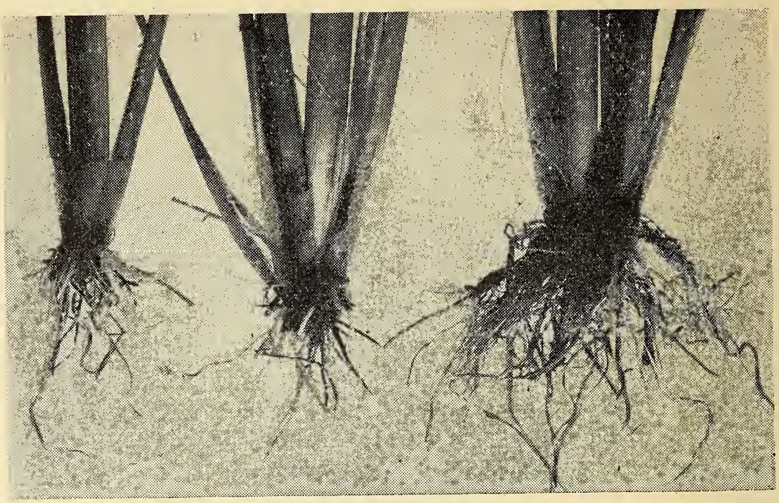

Fig. 1. A healthy rice plant (right) and two plants affected with root rot (center and left).

CAUSE

More studies are necessary before the specific cause of the root rot can be determined. There seems to be an accumulation of alkali in a root rot area and the p^h of the soil is usually higher than in other parts of the field. When the roots are examined, the root maggot (*Lissorhoptrus simplex* (Say) is usually found infesting them. However, since this insect is also found in rice roots from healthy fields, and has been proven to cause only negligible injury under ordinary rice field conditions, it is not considered the primary cause of the trouble (3). Species of Pythium are also found in the rotted roots, but attempts to produce the characteristic disease with this organism alone, or combined with the root maggot, have been unsuccessful in soil from unaffected areas.

MATERIALS AND METHODS

Only one fertilizer was used in the experiments. This was a 10-10-0 fertilizer made by mixing equal quantities of 20% ammonium sulfate and 20% acid phosphate. These two materials were used, as it was felt that they might have a more lasting corrective effect by reducing the alkalinity of the soil. The fertilizer was applied at the rate of 400 lbs. per acre.

The fertilized and check plots were usually 36 by 100 feet. In one experiment they were 18 by 100 feet. There were two replications in each experiment on drained areas in all tests except two. In one of these, three replications were used, and in the other, only one. The fertilizer was applied by scattering it by hand over the plots. To determine yields, plants from areas 3 by 15 feet were harvested from several places (usually five) in each plot and threshed separately. The rice was then weighed and the necessary calculations made to give the yields in barrels (162 lbs.) per acre.

TESTS ON UNDRAINED ROOT ROT AREAS

In 1939 and 1940 most of the tests were made by applying the fertilizer on the surface of the water without draining the field. The results of six tests with four varieties of rice, Blue Rose, Early Prolific, Rexoro, and Lady Wright, on 4 farms, are given in Table 1. Little increase in yield resulted from the use of the fertilizer, only .9 of a barrel per acre more rice being obtained from the fertilized areas than the check areas. Root rot was not severe in these tests and yields from the unfertilized plots were relatively high, averaging 12.6 barrels per acre.

TABLE 1. Comparative Yields of Rice in Unfertilized Plots and Plots Fertilized With 10-10-0 Fertilizer at Rate of 400 Lbs. Per Acre. Fertilizer Applied Without Draining Water From Field; Root Rot Severity Moderate

Farm	Variety	Date fertilizer applied	No. replications	Yield per Acre in Barrels		Differences
				Check	Treated	
J. Heinen	Blue Rose	June 6, 1939	2	14.3	12.1	− 2.2
"	Early Prolific	May 24, 1939	2	14.9	15.7	+ .8
Wm. M. Hoyt	Lady Wright	June 5, 1939	1	9.6	10.7	+ 1.1
"	Rexoro	June 5, 1939	1	18.7	18.8	+ .1
L. B. Lawson	Blue Rose	June 28, 1940	1	7.8	11.2	+ 3.4
J. Zaumbrecher	Blue Rose	May 23, 1940	2	10.0	12.0	+ 2.0
Average				12.6	13.4	+ .9

TESTS ON DRAINED ROOT ROT AREAS

At the same time that the fertilizer was applied to undrained areas, other root rot spots were drained and fertilizer applied at the same rate of 400 lbs. per acre. Only the major part of the water was removed and often there was an inch or more of water on areas in the plots. The fields were not permitted to dry out. After the fertilizer was put on, the fields were then reflooded within the next few days. The results of these experiments made over a period of five years, on six farms, are given in Table 2.

TABLE 2. COMPARATIVE YIELDS OF RICE IN FERTILIZED AND UNFERTILIZED PLOTS IN ROOT ROT AREAS. A 10-10-0 FERTILIZER WAS APPLIED AT RATE OF 400 LBS. PER ACRE AFTER DRAINING

FARMER	PARISH	Severity of root rot	Date fertilizer applied	YIELD PER ACRE IN BARRELS		Increased yield
				Check	Treated	
			Blue Rose			
Smith	Acadia	Severe	June 19, 1939	10.0	19.1	9.1
J. Heinen	"	Moderate	May 28, 1940	12.4	16.0	3.6
"	"	Moderate	July 8, 1940	13.2	16.9	3.7
"	"	Moderate	July 15, 1940	14.0	18.5	4.5
"	"	Mild	Aug. 1, 1941	10.0	11.6	1.6
"	"	Severe	July 14, 1943	5.7	11.0	5.3
Lawson Estate	"	Moderate	July 1, 1940	6.9	9.7	2.8
L. B. Lawson	"	Moderate	June 29, 1940	9.2	13.4	4.2
J. Zaumbrecher	Vermilion	Mild	June 27, 1941	12.4	12.8	.4
Dugas	Calcasieu	Severe	July 21, 1941	5.7	8.7	3.0
			Rexoro			
Lawson Estate	Acadia	Severe	June 23, 1941	4.5	6.3	1.8
P. Lambert	"	Severe	Aug. 11, 1942	3.6	10.0	6.4
J. Zaumbrecher	Vermilion	Mild	July 2, 1943	7.2	7.7	.5
			Fortuna			
P. Lambert	Acadia	Moderate	July 2, 1943	9.2	12.7	3.2
AVERAGE				8.9	12.5	3.6

Increases in yield of fertilized plots over unfertilized plots ranged from .4 of a barrel per acre to as much as 9.1 barrels per acre. The average yield from the 14 experiments was 8.9 barrels per acre in the untreated areas and 12.5 barrels per acre in the fertilized areas, or an average increase of 3.6 barrels of rice per acre where fertilizer was used.

Little increase was found in two years tests on one farm, that of Mr. J. Zaumbrecher near Gueydan. The reason for this is unknown, although in one experiment, not given in this bulletin, where potash was included in the fertilizer, the plots with potash gave a considerably higher yield than those with the 10-10-0 mixture which contained no potash. Further studies will be necessary before it is known whether the potash was responsible.

It is interesting that in the three experiments with the variety Rexoro only one gave an appreciable increase. This was in 1942 on the farm of Mr. P. Lambert, where the fertilizer was applied August 11, much later than in the other two experiments. It is possible that fertilizer should be applied later to Rexoro than to other varieties because of its late maturity. With Blue Rose, little difference was noted whether the fertilizer was applied in June or July.

The value of the increased yields is given in Table 3. In order to have a basic price of rice to calculate the increased value the so-called "ceiling prices" were used. Blue Rose and Fortuna were valued at $6.15 a barrel, and Rexora at $7.05 a barrel. The cost of the fertilizer was calculated at $34.00 a ton or $6.80 an acre for a 400 lb. application. There was a net gain, after the cost of the fertilizer was deducted, of $17.19 per acre in the eight tests with Blue Rose, $13.65 per acre in the three tests with Rexoro, and $12.88 per acre in one test with Fortuna. The average was $14.57 per acre for the five years' experiments. This seems sufficiently large to justify the use of fertilizer on root rot areas with present rice prices.

TABLE 3. VALUE OF INCREASED YIELDS IN RICE FROM APPLICATION OF 10-10-0 FERTILIZER AT RATE OF 400 LBS. PER ACRE

FARM	No. years tests	Increase in barrels per acre	Value at ceiling prices	Value after cost of fertilizer deducted*
Blue Rose ($6.15 per barrel)				
J. Heinen	3	3.7	$22.76	$+15.96
Smith	1	9.1	55.97	+49.17
Lawson Estate	1	2.8	17.22	+10.42
L. B. Lawson	1	4.2	25.83	+19.03
J. Zaumbrecher	1	.4	2.46	− 4.34
AVERAGE		3.9	$23.99	$+17.19
Rexoro ($7.05 per barrel)				
P. Lambert	1	6.4	$45.12	$ 38.32
Lawson Estate	1	1.8	12.69	5.89
J. Zaumbrecher	1	.5	3.53	− 3.27
AVERAGE		2.9	$20.45	$ 13.65
Fortuna ($6.15 per barrel)				
P. Lambert	1	3.2	$19.68	$ 12.88
AVERAGE OF ALL TESTS		3.6	$21.37	$ 14.57

*Cost of fertilizer figured at $34.00 per ton or $6.80 for 400 lbs.

SUMMARY

The results of five years experiments to test the effect of applying a 10-10-0 fertilizer at the rate of 400 lbs. per acre on root rot areas of rice are reported. The fertilizer was made by mixing equal quantities of 20% ammonium sulfate and 20% acid phosphate. Little increase in yield was found where the fertilizer was applied without draining. When the areas were drained and the fertilizer was then applied, an average increase of 3.6 barrels of rice was obtained.

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Louisiana Bulletin No. 380 June, 1944

FOREST GRAZING IN RELATION TO BEEF CATTLE PRODUCTION IN LOUISIANA

By

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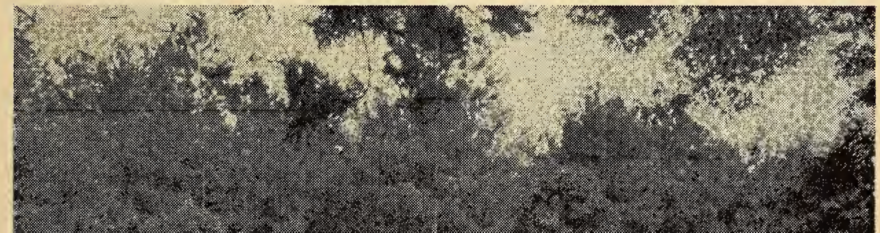

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AND
AGRICULTURAL AND MECHANICAL COLLEGE
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FOREST GRAZING IN RELATION TO BEEF CATTLE PRODUCTION IN LOUISIANA[1]

Results of a Survey of 118 Cattle-Producing Farms

By Robert S. Campbell and Robert R. Rhodes[2]

INCREASED INTEREST IN CATTLE RAISING

Cattle raising has been an important agricultural enterprise in Louisiana and the Gulf States for more than two centuries. The industry expanded leisurely, until the past decade, when there was a sudden growth of interest as shown by increased numbers of animals, better quality of herds, and more adequate care and feed provided them on many farms. There were 1,366,000 cattle and calves in Louisiana on January 1, 1944, an increase of approximately 20 percent during the previous 5 years, according to estimates of the U. S. Bureau of Agricultural Economics. The per-head value of all cattle in the State in 1944 was the highest on record. The number of farmers keeping cows mainly for beef production increased by more than half from 1930 to 1940, according to U. S. Census records, and more and better bulls of the beef breeds were put into service. Great strides were made in improving farm pastures and in growing feed crops. This steady increase in cattle raising is a natural result of the need for more meat and milk in the diet of our people and reflects the advantages of raising these health-giving foods at home.

Now, as for the past 200 years, forest range furnishes much of the forage for livestock. Grass and other native herbaceous growth abound, annually producing up to a ton or more of dry weight per acre. However, this range livestock grazing has its problems. Farmers with cattle on forest land want more and heavier calves, fewer death losses, and generally more effective animal production from their combined forest range and farm pastures and feeds. Grazing and tree growing on the same land may cause conflicts such as reduction in forage, injury to tree seedlings, and damage from the use of fire. Research and extension are covering important phases of these problems including animal breeding, feeding and disease, improved pastures and feed crops, and forest growth and management. But farmers and forest land owners are asking for assistance on forest range, for information that will enable better management of their herds and farm feeds in relation to grazing and growing trees on forest land.

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[1] Investigations conducted by the Louisiana Agricultural Experiment Station in cooperation with the United States Department of Agriculture through the Forest Service, Bureau of Animal Industry, and Bureau of Plant Industry, Soils and Agricultural Engineering.

[2] Robert S. Campbell, Southern Forest Experiment Station, Forest Service, U. S. Department of Agriculture; Robert R. Rhodes, Farm Forester, Louisiana Agricultural Experiment Station, on loan from Louisiana State Division of Forestry, Oct. 27, 1943, to Jan. 31, 1944.

A cooperative study of forest grazing in Louisiana was initiated in 1943 to help answer some of the most pressing problems, particularly those arising from the wartime need for more effective beef production. An extensive survey of representative farms with cattle grazing on forest lands was made in different parts of the State. The results, presented in this report, include: (1) a brief description of the forage and extent of cattle grazing in the different types of forest range in Louisiana; (2) the prevailing cattle management practices, including breeding, feeding, handling, and marketing; with special emphasis on improved practices; and (3) the main problems in forest grazing requiring more intensive experimental study, both livestock production and the dual use of land for livestock grazing and timber growing.

The practices employed by the more successful farmers in obtaining larger calf crops, heavier calves, and fewer death losses in conjunction with improved farm and forest management should be helpful to all those who graze herds on forest ranges in Louisiana and adjacent Gulf States.

LOUISIANA FOREST RANGES

The 16 million acres of forest land in Louisiana are usually separated into 4 broad divisions known as the northwest pine hills, southwest cutover pine, southeast pine or Florida Parishes, and the vast Delta hardwoods of the Mississippi and Red River valleys.[3]

The northwest Louisiana hill lands are well drained, predominantly light-colored sandy or red clay soils, varying in elevation from about 100 to 400 feet. There are nearly 4 million acres of forest, predominantly shortleaf-loblolly pine-hardwoods. Some 86 percent of the forest area is classed as second growth, with about 13 percent old growth, and only 1 percent clearcut. The understory available for grazing includes many native grasses such as the bluestems[3a] or "broomsedges," panic grasses, and three-awns or "wiregrasses." Carpet grass and Bermuda grass have become naturalized in many of the forest areas, and furnish considerable forage. There are also shrubs such as viburnums or haws, blueberries, huckleberries, and others.

The southwest Louisiana forest area of about 4 million acres was once one of the best longleaf pine types in the South. Great areas have been clearcut, although portions have come up in second growth. The country is flat to rolling, with elevation varying from about 50 to 200 feet. The

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[3] Winters, R. K.; Ward, G. B., Jr.; and Eldredge, I. F. Louisiana Forest Resources and Industries. U. S. Dept. Agr. Misc. Pub. 519, 44 pp., illus. Aug. 1943.

[3a] Common and botanical names of the range plants mentioned in this bulletin are listed on page 43.

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Young beef type steer with native cow grazing native forage grasses in an opening after cutting in loblolly pine-hardwoods. North Louisiana. Photo Dec. 11, 1943.

native forage is similar to the pine type farther north, with the addition of abundant annual three-awn grasses and with fewer shrubs, probably because of the more frequent range fires. Carpet grass is the main naturalized forage plant, particularly on the more closely grazed areas.

Southeast Louisiana, or the Florida Parishes, includes nearly 2 million acres of forest land in two main types: the longleaf-slash pine in the eastern portion and the loblolly-hardwoods in the western portion. Topography and elevations are similar to southwest Louisiana. The forest and the understory of forage are essentially similar to the types described, with the addition of such grasses as paspalums, muhlys, lovegrasses, and such shrubs as gallberry.

The great Delta or bottomland hardwood region is the largest forest type in Louisiana, containing more than 6 million acres. It runs the length of the State, varying in elevation from sea level to about 100 feet. Soils are mainly dark or red clay loams. The extensive stands of bottomland hardwoods have been largely cut over and are now in second growth. The better-drained areas, supporting oaks, tupelos, and sweetgums, are highly regarded by cattlemen as winter range. In addition to the hardwood sprouts, the main forage is found in such grasses as maidencane, switch cane, and in palmettos. Since the survey was concerned primarily with forest grazing, no attempt was made to cover the best farm and pasture land parishes of the Delta. Neither did it cover some 11 parishes in south Louisiana, which are predominantly prairie and marsh, although they do have considerable range grazing.

Weather directly influences both range forage production and grazing. Louisiana weather is typical of the Deep South—long, warm, moist summers favorable to rank growth of vegetation. The average frost-free season varies from about 250 days in the south to 230 days in the north part of the State. Maximum daily temperatures average between 90° and 100°F. during July, the hottest month, with high relative humidity. Winters are open and mild with only occasional cold "northers." Lowest daily winter temperatures average around 40°F. in the south part of the State, somewhat lower in the north. Although snow is rare except in north Louisiana, there are many days with cold, chilling rains and raw winds that are hard on animals without shelter. Average annual rainfall varies from about 45 inches in the northwest to over 60 inches in the southeast parishes. There is usually a late summer and early fall dry spell during the months from August to November that, because of its drying effects on pasturage, poses a serious grazing problem. Also, parts of north Louisiana frequently have dry weather in June. This combination of hot, humid summers and occasional chilling winter days requires long acclimatization by cattle before they thrive.

The number of cattle in the different forested sections of the State is rather closely related to the forest area, i.e., the more forest range, the more cattle. According to the U. S. Census for 1940, all cattle in the northwest parishes numbered 223,000, in the southwest 172,000, in the southeast 131,000, and 305,000 in the Delta. In addition there were 221,000 in the prairie and marsh sections of the State. The average number, per farm reporting, for the entire State was 10 head, with less than 7 head per farm in the northwest, and 12.5 in the southwest. Farms keeping beef cattle averaged somewhat larger numbers, but nevertheless indicate the importance to the small farmer of effective production from a relatively small number of cattle. The 1940 Census reported nearly 1.5 million acres in farm pasture. The main cultivated crops in the forest sections of the State are cotton, rice, sugarcane, truck crops, and feed crops, including corn and oats. Important hay crops are grasses, clovers, lespedezas, and soybeans. However, Louisiana imports some feed. It will become fully self-sufficient only when its own acreages of improved pasture, hay, and feed crops are expanded and better coordinated with forest range grazing so as to furnish adequate yearlong nutrition of its livestock.

Control of cattle varies considerably in different parts of the State, depending mainly on the livestock fence regulations in the individual parishes. By and large, free or unfenced range for cattle is the custom in the southwest cutover longleaf pine area and in the longleaf-slash pine of the eastern Florida Parishes, with some minor exceptions. The shortleaf-loblolly-hardwoods area of northwest Louisiana and the west

Florida Parishes and much of the bottomland hardwoods type lie in parishes in part or all of which livestock is required to be confined by fence.[4] However, the Delta lands included in this study are largely those parishes or wards in which forest grazing, usually with free range, is still the custom. In the parishes with unrestricted grazing, livestock have access to free forest range, including idle fields, roadsides, levees, railroad rights-of-way, and other waste areas.

HOW THE SURVEY WAS MADE

The study was made in 34 of Louisiana's 64 parishes. The aim was to obtain a representative cross section of the farmers using pine forest land for cattle grazing, although several farms predominantly in bottomland hardwood range were included. Farmers were interviewed who had 10 or more beef cattle grazing at least a part of the year on forest range. Some milk cattle were included, but commercial dairies were excluded from the study, although wide use of forest range is made by dairy herds in Louisiana. Names of farmers were secured from several sources and checked with the county agent in each parish.[5] Although many operators were selected at random, those making the survey felt that most of the farmers interviewed were as a group above the average in their farming operations.

A total of 118 interviews was made during October, November, and December, 1943. All interviews, averaging 3 or 4 in each parish (Fig. 1), were made by the authors, who worked together the first 2 weeks to attain uniformity. The interviewers discussed with the farmer his experiences and problems in using his land for grazing and timber production, and when possible examined the condition of the forest areas as well as the cattle and pastures. A schedule was filled out regarding the farm, its forage and feed resources, forestry operations, the management of the cattle, and the farmer's opinions of the main forest range problems.

THE FARMS AND CATTLE HERDS SURVEYED

The farmers interviewed were experienced stockmen; 82 percent had been raising beef cattle for more than 10 years, 12 percent 6 to 10 years, and only 6 percent less than 5 years. Of the 118 farms surveyed, 45 were located in northwest Louisiana, 31 in the southwest, 22 in the Florida Parishes, and 20 in the Delta on the fringes of the pine types. Grouped by forest types, there were 55 in the shortleaf-loblolly-hardwoods and 43 in the longleaf-slash. Because of better soil and farming conditions in the Delta, no attempt was made to cover all the parishes in the bottom-

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[4] See map (p. 20) with "Land Economics," by Bueford M. Gile, *in* Agr. Res. in La. (Ann. Rept. 1941-42).

[5] The ready help of Louisiana county agents and wholehearted cooperation of the farmers interviewed in furnishing the information on which this bulletin is based, are gratefully acknowledged.

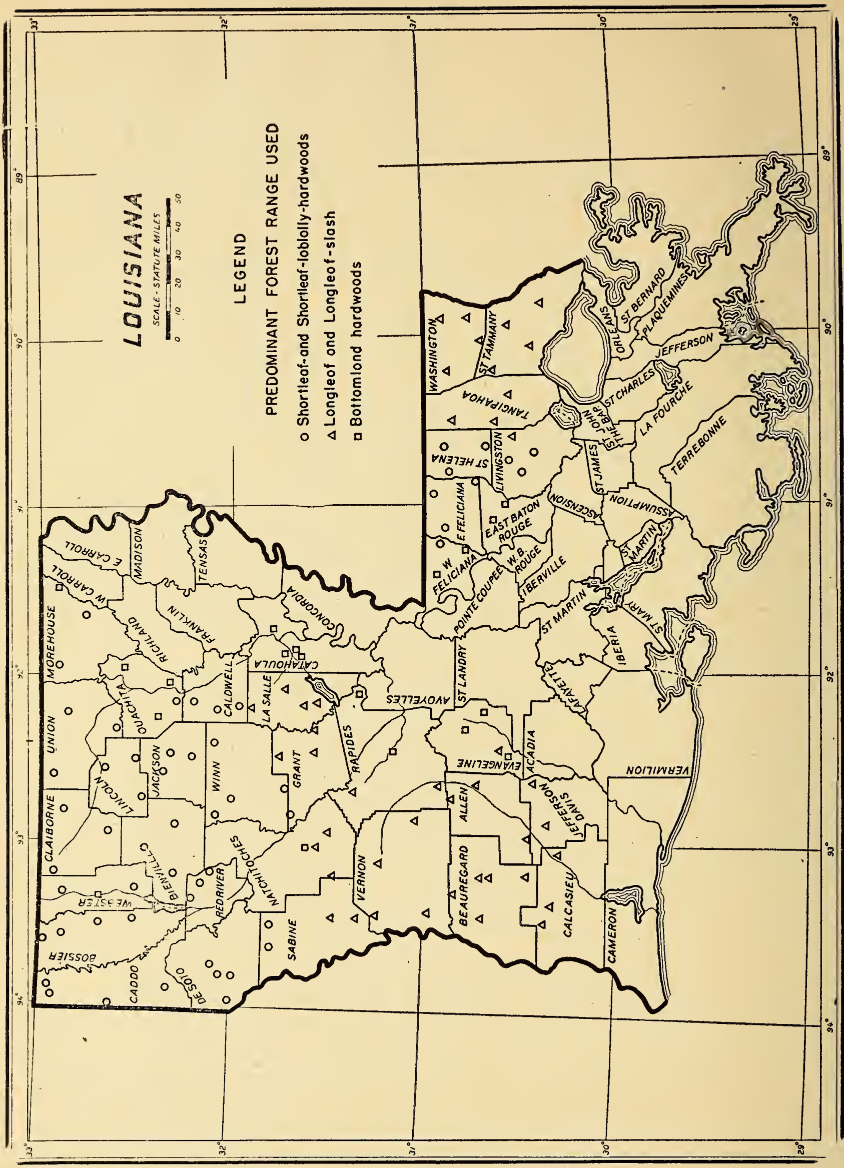

Fig. 1.—Location and main forest type grazed by cattle on farms included in survey of Louisiana forest grazing.

land hardwoods type. However, 20 farmers mainly in the free range Delta parishes were interviewed for comparison with grazing in the pine types.

The farms surveyed averaged 516 acres of forest, pasture, and cropland (Table 1). The average of all farms in the State was only about 67 acres, according to 1940 U. S. Census, but most good management practices apply on large and small farms alike, particularly where other forest range is available to expand the basis of operation. Forest land owned averaged 51 percent of the acreage of the farms surveyed, while forest composed 70 percent of the land in the forested parishes of the State. The farms studied varied from 72 percent forest in the Florida Parishes to only 20 percent in the Delta, with 57 percent in the southwest and 47 percent in the northwest. About 14 percent of the farmers interviewed were protecting a part of their forest land from grazing, averaging 7 percent of the forest land in all the farms surveyed. A larger number—nearly 30 percent—were interested in clearing at least a part of their forest for pasture, although 85 percent of the farmers interviewed desire to make best use of the bulk of their forest land for both trees and grazing.

TABLE 1.

LAND DEVOTED TO DIFFERENT USES IN FARMS SURVEYED

USES	North-west	South-west	Florida Parishes	Delta	Average all types
	AVERAGE NUMBER OF ACRES PER FARM				
*Land in farms**					
Forest land	215	292	481	97	265
Permanent pasture	80	95	90	288	121
Feed crops	89	58	56	64	71
Other crops	71	65	41	41	59
TOTAL	455	510	668	490	516
Additional forest land grazed:					
National forest and leased land	171	1,886	0	98	577
Free range	1,750	5,385	3,991	8,845	4,325
TOTAL FOREST RANGE GRAZED	2,123	7,560	4,119	9,024	5,149

*Includes owned forest land (of which 7 percent is not grazed), also owned and leased farm pasture and cropland.

In every section of the State, the amount of forest land actually grazed is greatly increased by the use of additional forest range, either under lease or national forest permit or free range. In the pine types, the greatest total acreage of forest range used per farm was in southwest Louisiana, next in the Florida Parishes, and least in the northwest. The figures in part reflect the status of livestock fence restrictions in various sections of the State and the size of the herds. Free range grazing is practiced at least part of the year by 64 percent of all farmers interviewed, being most prevalent in the Florida Parishes with 73 percent and in the southwest with 68 percent; and least in the northwest. The Delta farms, while having a small acreage of owned forest land, were so located as to have access to huge areas of free range.

The Kisatchie National Forest furnishes large areas of range for the use of local stockmen in parts of Winn, Grant, Natchitoches, Rapides, and Vernon Parishes. These lands, mostly fenced and managed, are grazed for a nominal fee under permit from the Forest Service, U. S. Department of Agriculture.

The leased range usually is under agreement between farmer and timberland owner providing for control of livestock, grazing, and fire on definite areas of forest land. A special study in Beauregard Parish led to the conclusion that farmers having 640 acres or more of land available for use have a fair chance for success from the standpoint of land resources.[6] Thus the leasing of such large blocks of forest land to responsible resident farmers to fence up and graze their livestock, in exchange for protection from fire and timber trespass, appears to be a worth-while movement which benefits both the timberland and livestock owners.

The majority of the beef cattle herds surveyed was rather small. About one-half had less than 76 head of cattle, and only 28 percent had more than 125 head (Table 2). Several herds were encountered with a thousand or more cattle, with the largest at approximately 1,800 head. The smaller herds from 10 to 75 head predominated in the northwest and in the Florida Parishes, while the percentage of larger herds of 126 head and up predomnated in the southwest and in the Delta, where the greatest areas of free range were available. Farmers in many parishes where there are livestock fence laws feel that it is only a question of time until most of the forest range is brought under control, with a reduction of large free range herds to smaller, better-fed, and more productive herds.

TABLE 2.

CATTLE HERD SIZE CLASSES ON FARMS SURVEYED

SECTION	10-25	26-75	76-125	126+	TOTAL
	NUMBER OF FARMS				
Northwest	12	19	5	9	45
Southwest	5	5	10	11	31
Florida Parishes	3	10	5	4	22
Delta	2	6	3	9	20
TOTAL	22	40	23	33	118
PERCENT	18.6	33.9	19.5	28.0	100.0

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[6] Gile, Bueford M. Economic Utilization of Rural Land Resources in Beauregard Parish, Louisiana. La. Agr. Expt. Sta. Bull. No. 322, 35 pp., illus. June 1940.

GRAZING USE OF FOREST LAND

Forest grazing varies so greatly in different parts of Louisiana that a satisfactory understanding of the situation can be obtained only by considering several main features, including amount and intensity, season, and distribution of use.

Amount and Intensity of Grazing

Forest ranges accounted for 69 percent of the yearlong sustenance of cattle on the farms surveyed, based on the feed value of the estimated amount of grazing and supplements obtained from all sources throughout the year (Table 3). Forest range furnished more than the average in the southwest, with 81 percent, and less in the northwest, with 54 percent. This contrast would be expected from the greater acreage of forest range used per farm in the southwest and is shown further by the fact that only 3 percent of the year's sustenance came from permanent pasture in the southwest, versus 27 percent in the northwest. As the improved pasture and forestry programs in Louisiana gain headway, increasing amounts of the year's feed will come from permanent pasture. This will be a sound development, as many herds are now left on forest range for a longer season than the forage will maintain them at a satisfactory nutrition level.

TABLE 3.

YEARLONG SUSTENANCE FURNISHED BY VARIOUS FEED SOURCES ON FARMS SURVEYED IN LOUISIANA

SOURCE OF FEED	North-west	South-west	Florida Parishes	Delta	Weighted average
	PERCENT				
Forest grazing	54	81	65	57	69
Permanent pasture	27	3	23	34	17
Field crops (grazing)	8	10	2	3	7
Feeding (supplemental)	11	6	10	6	7
TOTAL	100	100	100	100	100

It is sometimes said that the grazing capacity—that is, the number of acres required to carry a cow during the proper grazing season—on southern forest ranges is too low for profitable cattle raising. However, forest range has a relatively high grazing capacity when compared to the usual run of western range land, which requires from 20 to 100 acres per cow yearlong, depending on the location and condition. Louisiana farmers' estimates for all forest types averaged about 11 acres per head for a grazing season varying from 5 months to yearlong. The longleaf type is generally regarded as having higher grazing capacity because the stand of trees is more open, hence the grass is more dense than in the shortleaf-loblolly-hardwoods type. Information on the true grazing capacity of Louisiana forest ranges will be indefinite until further studies bring out what plants furnish the bulk of the forage through the seasons and the intensity with which the forage can be used satisfactorily. Where large areas of forest range are available, the accurate determination of grazing capacity and correct season of use is the key to the development of other feed supplies such as farm pastures and supplements to round out the year's grazing.

Season of Use

Louisiana forest ranges are grazed during all seasons. Sixty-eight farmers, or 58 percent of those interviewed, grazed cattle on forest range throughout the year (Table 4). Yearlong grazing is more characteristic of the longleaf pine type, where it was practiced by nearly two-thirds of the farmers mainly because of available free range, and more open winters in the southern part of the State. It was also practiced by three-fourths of the farmers interviewed in the bottomland hardwoods. In contrast, fewer than half the farmers in the shortleaf-loblolly-hardwoods type practiced yearlong grazing, mainly because of fence laws and more

TABLE 4.

SEASON OF FOREST GRAZING BY CATTLE ON FARMS SURVEYED IN LOUISIANA

APPROXIMATE DATE	North-west	South-west	Florida Parishes	Delta	TOTAL
	NUMBER OF FARMS				
Put on:					
January 1	5	1	0	1	7
March 1	4	6	3	0	13
April 1	8	3	2	2	15
June 1	1	1	0	2	4
October 1	3	0	0	0	3
November 1	2	0	0	0	2
December 1	3	2	1	0	6
Removed:					
March 31	5	0	1	2	8
April 30	1	1	0	0	2
August 31	1	2	0	0	3
September 30	2	6	0	0	8
October 31	10	1	1	0	12
November 30	4	0	1	1	6
December 31	3	3	3	2	11
Yearlong:	19	18	16	15	68
TOTAL	45	31	22	20	118
PERCENT YEARLONG	42.2	58.1	72.7	75.0	57.6

severe winters in north Louisiana. Most operators who grazed cattle on forest range yearlong had a desirable combination of pine forest for spring and summer grazing, with bottomland hardwoods for winter. Many fenced pine ranges were grazed for their feed value during the green forage season, then used in winter as shelter for the livestock, which also had access to fields, pastures, and cover crops for roughage.

Where seasonal use of the pine types is practiced, about 7 months of grazing is obtained averaging from March 15 to mid-September in the longleaf-slash pine type; and from April 1 through October in the shortleaf-loblolly pine-hardwoods type. The exact season usually depends on the amount of farm feeds available for fall and winter, and partly on the weather. Cattle are usually turned out earlier in the southern part of the State than in the northern part, 200 miles away. Farmers report that cattle do rather well on forest range in spring and early summer, then they may lose some weight during the midsummer dry season but pick up again in the fall when grasses come into seed and the forage greens up again. After grasses dry in late fall, cows lose considerable weight and, if left on the range, are usually given some supplemental feed during the winter.

Improved season of use appears to be one way in which Louisiana cattlemen depending on forest range can bring about immediate betterment in cattle production. Forage samples, mainly green grass leafage, collected in December 1943 showed barely 4 percent protein, which is considerably below maintenance diet, even for a dry cow, and is far below that needed by a pregnant cow or one with calf at side. Furthermore, grass with even this much nutriment is so scarce during the winter, particularly on pine ranges, that it is difficult or impossible for cows to secure a fill. Thus breeding cows continuing to lose weight throughout the winter are in the poorest shape of the year by early spring, at the very time when they should be in at least fair condition to bring a calf and to furnish adequate milk for a young calf at side. Individual stockmen who remove their cattle to winter and spring pastures or furnish an adequate maintenance supplemental feed during the winter are being fully repaid in higher calf crops, larger calves, and lower losses, as will be brought out later.

Distribution of Grazing Use

Forest grazing is characteristically very patchy. The usual condition is to have some areas overgrazed, such as near roads, barns, and watering places. On the other hand, great areas of old fields and woods each year grow up into an abundant mass of grass and other dry vegetation or "rough." Many farmers feel that a greater number of cattle on the forest range for a shorter season would be beneficial in preventing so much of the fast-growing grass from maturing and drying out before the cattle could eat it.

Grazing in forest range will always be somewhat patchy owing to the greater amount of forage growing on firebreaks and in open spaces between groups of trees than in areas where the forest cover is more dense and shades out the grasses, or smothers them with accumulated litter. However, better distribution of grazing on forest range, particularly where the farmer has fenced control, deserves serious consideration. No doubt the installation of additional boundary and cross fences, of more improved watering places, and better distribution of the salt over the range would help to secure more even utilization of the forage.

MORE FARM PASTURES NEEDED

Although about 23 percent of the average farm surveyed was in permanent pasture, many of these were used so heavily for work stock, milk cows, and other animals, that they furnished only 7 percent of the yearlong sustenance of the beef cattle. Farm acreages in the pine types averaged only 17 percent pasture whereas stock farms surveyed in the Delta country with richer soils averaged 59 percent pasture. A great deal of farm pasture is still in comparatively low-producing species such as carpet grass and various native grasses. In recent years the improved pasture programs of the Louisiana Extension Service, the Louisiana Agricultural Experiment Station, the Agricultural Adjustment Agency, and the Soil Conservation Service have encouraged the seeding of an increased acreage of permanent pastures on good soils well limed, fertilized, and seeded to high-producing species such as Dallis and Bermuda grasses, lespedeza, and clovers.[7] Some excellent pastures, capable of producing 400 pounds or more of beef per acre annually, are found on Louisiana alluvial soils. Heifers and steers grazing improved pastures on north Louisiana hill farms are reported to have gained as much as 229 pounds per head from April to November.[8] A continued increase in improved

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[7] For pasture recommendations, see "Pasture and Feed—the Foundation for Profitable Livestock." La. Agr. Ext. Cir. 248, 30 pp., illus. Aug. 1943.

[8] Bray, C. I., et al. "Hill Land Pastures" (pp. 40-42) *in* Agr. Res. in La. (Ann. Rept. 1941-42).

Good beef type cows being wintered on permanent farm pasture adjacent to bottomland hardwoods in the Red River valley. Photo Dec. 9, 1943.

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pasture acreage is needed to provide more adequate and longer season grazing.

An important problem needing research, mentioned by 45 percent of the farmers interviewed, is to determine the type and amount of pasture and feed best adapted to furnishing winter and early spring forage during the season when forest grazing, especially in the pine types, furnishes only a below-maintenance diet. Many farmers have worked out successful rotations with forest range grazing, so as to give their improved pastures needed rest during spring and summer, and frequently in winter. Additional acreage of improved pasture was planned by 38 percent of the farmers interviewed, with the greatest proportion (53 percent) in the northwest.

GRAZING FIELD CROPS

A great variety of field crops is grazed after harvesting in the fall, in combination with forest range. These include aftermath in cornfields, cottonfields, and hayfields. In Calcasieu, Jefferson Davis, and southern Beauregard Parishes, rice stubble and fallow are also used as temporary pasture along with forest range. Nutrient aftermath such as corn nubbins, cotton bolls and stalks, soybeans, or peanuts is usually used to fatten animals to be sold in the fall so they will go to market in good condition. A few farmers grow velvetbeans in with corn and use them to fatten market animals.

The small grains, mainly oats, are used by many farmers for winter grazing when other feeds are scarce. Although high in water content and rather washy, they furnish green forage for a fill when most needed. The acreage of oats planted for 1944 was estimated as one-fourth greater than

Beef cattle from forest range turned into a cornfield for fall grazing. Note the considerable quantities of field grasses along with the crop aftermath. North Louisiana. Photo Dec. 9, 1943.

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Good beef cattle grazing on rice stubble and forest range, a special type of combined farming and forest grazing in southwest Louisiana. Photo Nov. 16, 1943.

the previous year. Increased use of such cover crops for winter grazing along with adequate concentrates for supplemental feed is no doubt desirable until such time as experiments can work out high-yielding improved pastures for winter grazing.

Altogether, field gleanings and temporary pastures furnished an average of 7 percent of the yearlong sustenance of the beef cattle herds surveyed, with more in the northwest and southwest than in the Delta and southeast.

SUPPLEMENTAL FEEDING

The farmers interviewed furnished about 7 percent of the yearlong sustenance of their herds for 1943 in the form of supplemental feeds. A larger proportion was furnished in the northwest where more cattle are kept under fence and winters are colder, and in the southeast where the influence of feeding for milk production is shown. The most common supplements fed were cottonseed meal and hulls, cottonseed cake, corn, and various kinds of hay including grass, soybean, lespedeza, and clover. The farmers raised somewhat over half of their supplemental feed, particularly hay and corn, but bought the balance. Rice straw is commonly fed beef cattle in the southwestern rice-growing parishes. Purchased feeds were mainly concentrates, including cottonseed and soybean products and also some hay. Many farmers grew just about enough cotton to trade in the cottonseed for sufficient meal and hulls to pull their cattle through the winter in reasonably fair shape. A few fed some whole cottonseed. Very few farmers grew enough feed to take care of their own livestock and still have any left to sell. This was particularly true in 1943 because of the serious summer drought which curtailed pasture and feed production. However, even in good years with present livestock numbers Louisiana is a feed-importing State except for protein supplements.

The average practice on forest ranges grazed yearlong is to furnish supplemental feed for about 90 days from around Christmas to late March. The average ration consists of about 1 pound of meal, 2 or 3 pounds of hulls, and in some cases a few pounds of hay, in addition to such low-maintenance roughage as the animals can pick up in fields or in the dry forest rough. This usually is inadequate to maintain the animals even in fair shape during the winter, and is reflected in low calf crops, lightweight animals, and excessive death losses both of cows and of calves because of their weakened condition.

A supplemental ration of about 20 pounds of roughage and 2 pounds of cottonseed meal or its equivalent per day for all grown cattle during the winter is recommended by the Louisiana Agricultural Extension Service, although if breeding cows start the winter in good shape, it is considered permissible to allow them to lose some weight during the winter. The farmers interviewed who provided their breeding herds anything like this level of winter nutrition were fully rewarded by high calf crops, heavier calves, and insignificant death losses.

Forest grazing experiments in south Georgia show that cattle fed a concentrated supplement such as cottonseed meal will rustle better for forage in the forest than when they are given simply a roughage such as hay.[9] Observations in Louisiana confirm this finding.

On the farms surveyed, dry-lot maintenance feeding and fattening together accounted for very little of the yearlong sustenance of the animals. Such supplemental feeding as is done for maintenance is carried out on forest range or in pastures, rarely in a dry lot, except for what farmers customarily call "the hospital bunch." Only 2 or 3 of the farms were engaged in fattening steers.

Only one farmer was found who practiced creep-feeding of calves, i.e., allowing calves access to additional feed, usually grain or other concentrate, in especially built pens, while remaining on pasture with their mothers. This practice has found wide approval in other parts of the

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[9] Biswell, H. H.; Shepherd, W. O.; Southwell, B. L.; and Boggess, T. S., Jr. Native Forest Plants of Cutover Forest Lands in the Coastal Plain of Georgia. Ga. Coastal Plain Expt. Sta. Bull 37, 43 pp., illus. Aug. 1943.

South, and should help produce heavier calves on forest range in Louisiana.[10]

Facilities for handling supplemental feeding varied greatly. The better-managed farms usually had sufficient troughs and racks, but generally much more efficient use would be made of feed if more adequate facilities were available. Many farmers used hammer mills to convert corn and other feeds into more digestible form; several of these served whole communities. On the farms surveyed only one silo was found in use for feeding beef cattle.

Beef cattle grazed on pine range are rarely given supplemental feed in summer. Likewise, many herds grazed during the winter season on bottomland hardwood range are brought through the winter without supplements, although usually in poor to fair condition. Altogether, it appears that where there is ample roughage on the forest range, it would be well to begin feeding cattle a little earlier in the fall or winter and feed more adequately, so the animals never become reduced to really gaunt condition. Even better is a bountiful supply of hay, supplemented by winter pasture where possible, during the period when forest grazing furnishes only a below-maintenance ration. Experimental work is needed to determine the best combination of management practices in supplementing cattle on forest range and in rounding out the year's feed supply with improved pasture.

Salt and Other Minerals

Four-fifths of the farmers interviewed furnished salt to their cattle at all times (Table 5). A few, mainly in the Florida Parishes, furnish salt only infrequently or not at all. Block salt is the most popular form, as it can be kept before the animals at all times without severe loss through weathering. However, many farmers use loose salt either because they call up the cattle at about weekly intervals to take salt or include it with a mineral mixture kept in self-feeding boxes.

The location of the salt is a phase that many farmers could give more attention on forest range, particularly where the land is under control, in order to bring about better distribution of the cattle over the range and more even utilization of the forage.

Mineral mixtures of various sorts were fed regularly on only 34 of the farms surveyed, or 29 percent. A greater proportion of farmers, nearly half, in the southwest fed supplemental minerals regularly because of the frequent occurrence of creeps, a disease caused by mineral deficiency, in that part of the State. The smallest percentage regularly feeding minerals occurred in the Delta where there is little deficiency because of the

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[10] Cobb, W. T. Creep Feeding Calves. La. Agr. Ext. Cir. 237, 6 pp., illus. June 1942.

TABLE 5.

SALT AND OTHER MINERALS FED TO CATTLE BY FARMERS INTERVIEWED

PRACTICE	North-west	South-west	Florida Parishes	Delta	TOTAL
	NUMBER OF FARMERS				
Salt fed:					
At all times	36	21	12	12	81
Weekly	7	5	1	5	18
Two weeks or less	2	5	5	3	15
None	0	0	4	0	4
TOTAL	45	31	22	20	118
Other minerals fed:					
Fed	8	15	7	4	34
Not fed	37	16	15	16	84
TOTAL	45	31	22	20	118

mineral content of the soil and forage. The mixtures fed vary all the way from ground oyster shell and steamed bonemeal (to supply calcium and phosphorus) to more elaborate commercial mixtures including such minerals as iron, copper, manganese, and cobalt. In most cases, "creeps" occur in animals grazing on forest range in the fall after the forage has dried and the minerals have leached out. A better season of grazing forest range is indicated. Many farmers report that they have temporarily cured the "creeps" by feeding the affected animals cottonseed meal for a few weeks in the feed lot or farm pasture.

Practical suggestions for feeding minerals to farm animals are available through the Louisiana Extension Service.[11] Further experimental work is needed to determine what minerals are deficient in different types of forest range forage, and how they can be made up through rotation grazing with fertilized, improved pastures and direct feeding of various mineral supplements.

IMPROVING HERD QUALITY AND BREEDING PRACTICES

Visitors to the South frequently express surprise and satisfaction at the improvement in quality of beef animals in the past 10 to 15 years. Twenty-one percent of the herds surveyed were grade cattle of good beef-type (Table 6). Fifty-eight percent were mixed grade and native stock. Only 8 percent of the herds were strictly native breeding cows, and 12 percent were mainly of dairy breeds, but used with beef-type bulls to produce calves with beef characteristics. Only one purebred herd was found grazing on forest range.

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[11] Cobb, W. T. Minerals for Livestock. La. Agr. Ext. Cir. 174, 4 pp., illus. June 1938.

TABLE 6.

QUALITY OF BREEDING HERDS SURVEYED

BREEDING	North-west	South-west	Florida Parishes	Delta	Average
	PERCENT				
Purebred	0	3	0	0	1
Good beef grade	13	23	18	40	21
Mixed grade and native	58	74	45	45	58
Native	0	0	32	15	8
Other (including dairy)	29	0	5	0	12
TOTAL	100	100	100	100	100

Herd Improvement

Beef cattle herd improvement in Louisiana is definitely gaining headway, as shown by the fact that 36 percent of the farmers interviewed started using better bulls only in the last 5 years (Table 7). Another 34

This little calf stayed home! An excellent prospect for a good beef type heifer, to be used when mature as a replacement for the native cow. Grazing on a longleaf pine plantation, Kisatchie National Forest. Photo Feb. 24, 1944.

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percent had been using better bulls from 6 to 10 years, while 20 percent had been improving their herds for 11 years or more. Farmers say they feel safe in investing in improved herds because losses due to cattle tick fever have been eliminated. Also better pastures and more feed are available, and forest grazing is gradually being better controlled and managed. Higher market prices and heavier animals are considered well worth the effort of breeding for better quality. However, most farmers state that it is wise to proceed carefully in importing fine-quality animals to graze on forest range. Most of them prefer to start with native cows well adapted to the temperature and forage conditions encountered on forest range, breed them to good bulls, and thus gradually improve the herd.

TABLE 7.

LENGTH OF TIME HERD IMPROVEMENT HAS BEEN PRACTICED

YEARS PRACTICED	North-west	South-west	Florida Parishes	Delta	Average
	PERCENT OF HERDS SURVEYED				
1-5	38	45	18	35	36
6-10	29	35	45	30	34
11 or more	22	10	23	30	20
Not practiced	11	10	14	5	10
TOTAL	100	100	100	100	100

One-third of the farmers interviewed secured their bulls from outside Louisiana in an effort to take advantage of recent improvements in the beef breeds under range conditions. An additional 46 percent purchased bulls from purebred herds within the State, while the balance were using only average-quality bulls. In general, the farmers believe in changing bulls sufficiently often to avoid inbreeding. Fifty-two percent stated that they change bulls about every 3 years. Forty-four percent wait until the bulls are 4 years or over, and a few farmers keep bulls until they are too old for further service. Many farmers trade bulls after about 3 years' service. Others with a large number of cows change bulls between parts of their herds.

Several beef breeds are popular, including regular and Polled Hereford, Aberdeen-Angus, Red Polled, Brahman, Shorthorn, and Devon. Practical research results are already available with cattle adapted to the South.[12] However, animal husbandmen realize that further experimental work is needed to develop the best type of animal with quality, good beef conformation, hardy and suited to forest grazing, and requiring a minimum of maintenance feeding during critical periods such as winter and early spring.

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[12] Rhoad, A. O., and Black, W. H. Hybrid Beef Cattle for Subtropical Climates. U. S. Dept. Agr. Cir. 673, 11 pp., illus. Feb. 1943.

In summary, the number and quality of bulls used in beef herds grazed on forest range in Louisiana indicates real progress in recent years. On the average, farmers are providing about 4 bulls per hundred cows, which, under ordinary range conditions, is recognized as an absolute minimum. It seems likely that farmers, particularly in large herds, might secure somewhat greater calf crops by using 5 bulls per hundred cows and attempting to secure better distribution of bulls through the herd, particularly during the main breeding season.

Seasons of Breeding and Calving

Most farmers recognize the values of a controlled breeding season in raising a more uniform calf crop, in bringing calves at a time when cows have sufficient feed and forage to produce the milk needed to keep calves growing rapidly, and in using bulls only when they are in top breeding condition. However, only 10 of the 118 farmers interviewed attempted to control the breeding season, usually keeping bulls with the cows during the spring and early summer. Bulls were run with the cows yearlong by 92 percent of the farmers. Many farms did not have enough separate pastures to control either the breeding season or the age at which heifers were bred.

Only 3 percent of the farmers, all in the northwest, stated that they kept bulls away from heifers until they were mature, usually about 2 years of age. However, others stated that their heifers mature so slowly under the rather low level of nutrition available on forest range grazed yearlong that they do not naturally breed until they are 2 years old, bringing their first calf at 3. Seventy percent of the farmers interviewed reported this condition. Nineteen percent, mostly with herds having some dairy blood, reported that their heifers breed at about 18 months of age, while 12 percent reported that their heifers usually breed first at the age of 3 years. Better-nourished heifers naturally mature and start paying their way at a younger age.

As would be expected in an area where yearlong breeding prevails, calves are dropped at all seasons of the year. However, the greater number of calves are born in the spring, with another group, somewhat smaller, in the fall. Ninety percent of the farmers indicated that their main calving season is in the spring, 8 percent in the fall, and 2 percent have their calves come more or less evenly distributed throughout the year. Those who control the breeding season prefer to have calves dropped in spring, so the cows on green grass will be in good shape to raise a calf and breed promptly. Also, spring calving is good protection against screwworm infestations.

CATTLE LOSSES

The herds surveyed in 1943 averaged 3.6 percent death loss for that year, as nearly as could be estimated. This ran up as high as 4.5 percent in the Florida Parishes, but was somewhat lower in the other sections of the State. However, many Louisiana farmers later reported that owing to the short feed supply as a result of the 1943 drought, cattle losses during the winter of 1943-44 were heavier than in years, in many cases running up as high as 8 to 10 percent. The main causes of loss reported were starvation, disease, drowning or bogging, highway or railroad accident, straying or theft, and poison plants. A considerable proportion of the losses reported were given as cause unknown. The 150 starvation losses reported up to the time of interview occurred mainly in early spring during February and March when range forage was short. These losses alone, if prevented, would have paid for substantial amounts of supplemental feeds at this season of year. The main causes of loss by disease were blackleg, charbon or anthrax, hemorrhagic septicemia, and Bang's disease. Poisoning from such plants as buckeye and Carolina jessamine may be higher than is generally supposed, and should be studied further. Several losses from poisonous mushrooms were reported in the fall of 1943.

The average mortality rate of calves among the herds surveyed was somewhat over 2.5 percent, and is rather high, as calves are usually sold at 6 to 9 months of age.

One clue to the rather high losses is found in the lack of preventive measures taken against diseases. Half of the farmers in the survey do not vaccinate their cattle or calves regularly against any disease, usually waiting until an epidemic strikes in the community before vaccinating. Forty-two percent of the farmers do vaccinate regularly for blackleg. Farmers in the Delta appear to take greater precautions than in other parts of the State, 55 percent of them vaccinating for blackleg, and 35 percent for anthrax.

Cattle thefts were reported on the increase until late in 1943 when restrictions on trucks, tires, and gasoline witnessed a reduction in this detestable activity.

Death losses are not the only losses suffered by cattlemen. For example, a nation-wide drive is being made to reduce losses in weight and thriftiness, as well as in market values of animals and hides, from cattle grubs. Another serious parasite is the screwworm. Farmers reported that this pest appears to cause real difficulty only periodically every 5 to 10 years. Screwworm infestations were reported to be worst during late summer, usually July, August, and September, and sometimes as late as October. Because of the periodic occurrence of severe infestations, 80 percent of the farmers interviewed take no regular precautions against screwworm in treating animals that have been branded, marked, castrated, or dehorned, and cows that have calved. However, they ordinarily plan their operations so as to handle cattle either in the spring or in late fall before or after the probability of severe screwworm infestation. Probably screwworm epidemics would be less serious if more farmers took regular precautions against them.

Most farmers conceded that lice and woodticks, when occurring in quantity, are a serious drain upon the vigor of their cattle. However, only 9 of the 118 farmers interviewed dipped their cattle regularly, although more were interested in doing so. Stomach worms and other internal parasites were recognized by a few farmers as a problem. Some, particularly dairymen, treated their cattle regularly with bluestone or copper sulphate solution. Preventive measures include proper stocking of pastures, rotation grazing, good drainage, and good drinking water.

Several farmers stated they had trouble with pinkeye during 1943, usually from buying an infected animal which spread the disease in their herds. Few death losses were reported, but the afflicted animals see so poorly and are undernourished for so long a period that they lose condition and ordinarily should be disposed of promptly.

Practical recommendations for preventing cattle losses due to the ordinary causes are available from the Louisiana Extension Service.[13]

CALF PRODUCTION RELATED TO FEED SUPPLY

The average calf crop of all the farms surveyed was slightly more than 50 percent, that is, 50 calves raised for each 100 breeding cows. The highest average was 58 percent for herds in the northwest, 52 percent for those in the Delta, with other parts of the State somewhat lower. The calf crops on the farms surveyed are somewhat below the estimated State average of around 60 percent which includes all types of operations such as purebred herds, dairy herds, and cattle on farms with good feed year round. Forest range figures would be expected to fall somewhat below the State average. The highest calf crops are reported by those farmers who furnish their cows with the best grazing and supplemental feed supply throughout the winter and early spring months, also by those who have the best control of the forest range on which their animals graze.

The cattle herds provided with adequate forage or feed throughout the year generally produced average calf crops of 65 to 85 percent, grew heavier calves, of 350 pounds or more, and had death losses of only 2 percent or less; whereas herds with inadequate winter feed and care produced calf crops of only 30 to 40 percent, grew lighter calves, around 300 pounds or less, and suffered losses of 6 to 8 percent or more.

Many farmers grazing cattle on forest range operate on the basis of keeping costs to a minimum, in the belief that better feeding and management practices will not necessarily pay out, although recognizing that such practices will increase calf crops and beef production. However, previous studies in Louisiana have shown a definite increase in net operating returns per farm in proportion to increases in calf crops.[14] Furthermore, during wartime the greatest possible output of beef is needed for civilian and military purposes and in the post-war period operating efficiency will be one of the main keys to success in the livestock business. Although additional experiments are needed to work out improved practices of forest range management that will increase herd production, the success of outstanding individual farmers interviewed shows that enough is known now regarding feed and care of animals on the range to increase average calf crops substantially.

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[13] Cobb, W. T. Beef Cattle—Herd Management. La. Agr. Ext. Cir. 226, 4 pp., illus. Dec. 1941 (reprint).

FURNISHING YEARLONG FEED FOR RANGE CATTLE

The survey revealed several basic types of farm operation in furnishing forage to range cattle throughout the year. They are essentially as follows:

1. Yearlong forest range with supplemental feed in winter.

2. Spring, summer, and early fall forest range grazing. Field gleanings in late fall; winter on field and cover crops, such as oats, with supplemental concentrates.

3. Spring and early summer forest range. Late summer and fall on improved pasture. Winter on improved pasture or forest range with supplemental feed.

4. Spring forest range. Summer, fall, and winter on improved pasture, perhaps temporary pasture in winter, also supplemental feed in winter.

The main differences between these types of operations are in the length of time the animals obtain their forage from forest range. They show a progressively better use of forest range during the season when it furnishes adequate nutrition. There are of course many variations within each type of operation. For example, in any of them the animals may have access to forest range for shelter at any time of the year, and for shelter and low-value roughage through the winter.

The levels of nutrition represented within these types of operation may be grouped into *poor, fair,* and *good.* These vary somewhat as follows through the year:

1. POOR. Animals in fair condition on green forage during late spring, summer, and fall; in poor condition during winter and early spring, with no supplemental feeding or with merely existence supple-

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[14] Merrick, Frank, and Efferson, J. Norman. Farmer Experience with the Beef Cattle Enterprise in Louisiana. La. Agr. Expt. Sta. Bull. 353, 31 pp., tables. Aug. 1942.

mental feeding of weak cows. Characteristic of herds grazed yearlong on forest range with inadequate winter feed.

2. Fair. Animals in good condition during spring, summer, and fall; in fair condition during winter and early spring, with what might be called submaintenance supplemental feed—that is, no attempt to prevent considerable loss in weight but with definitely enough supplemental concentrates to keep breeding cows in fair condition to bring calves and breed in the spring. Found mainly in herds grazed for a long season on forest range, but also those on farm pasture with too many animals for the feed available.

3. Good. Animals in good condition yearlong. They may perhaps decline to fair condition in winter, but are supplied adequate feed and permanent pasture in winter and spring. Characteristic of herds grazed on forest range during proper season, with plenty of feed at all times.

Some of the farms surveyed have been selected to illustrate these types of operations and levels of nutrition, as shown in table 8. The main differences are in the level of nutrition furnished the animals during the winter. The returns to farmers providing adequate yearlong nutrition for their breeding herds are evidenced in the higher calf crop percentages, in the heavier calves, and in lower losses.

MORE RANGE IMPROVEMENTS NEEDED

Range improvements include such items as boundary and cross fences, water developments, shelters, feeding troughs, salt boxes, corrals, and other structures to facilitate grazing, handling, and health of the cattle throughout the year. With huge areas of forest range, abundant rainfall, ample water in creeks, bayous, and ponds, mild weather, and with low-priced native cattle, most cattlemen formerly did not feel it necessary to incur any great expense for range improvement. However, many range improvements are needed for proper care of the better-grade and more valuable cattle now being grazed.

Large acreages of forest range were fenced up during the decade prior to the war in some localities, such as eastern Washington Parish and parts of Beauregard Parish. In other parts of the State, unfenced range is still predominant except on such areas as the Kisatchie National Forest where pastures as large as 44,000 acres are under hogproof fence for the control of livestock in connection with both forest and range management. Most of the farmers interviewed had their own farm woodlot fenced and many planned additional fencing of owned or leased forest range as soon as materials and labor become available at the close of the war. Boundary and cross fences are essential in the control of seasonal and rotation grazing of livestock, both on farm pastures and on forest range. Many farms are in need of better corrals for handling and loading cattle; also, facilities for creep-feeding calves.

TABLE 8. YEARLONG NUTRITION IN RELATION TO BEEF CATTLE PRODUCTION ON REPRESENTATIVE FARMS USING FOREST RANGE

LEVEL OF NUTRITION, TYPE OF OPERATION, AND LOCATION	SEASONAL SUSTENANCE OF CATTLE				CALF CROP	CALF WEIGHTS	CATTLE LOSSES
	SPRING: APRIL–JUNE	SUMMER: JULY–SEPT.	FALL: OCTOBER–DECEMBER	WINTER: JANUARY–MARCH	*Percent*	*Pounds*	*Percent*
Good yearlong nutrition:							
Farm and national forest range, fenced. Southwest Louisiana.	Fenced forest range.	Fenced forest range.	Improved pasture.	Improved pasture. 100 days' supplement, 2 lbs. cottonseed meal and 4 lbs. hulls per head per day.	78	355	2.0
Rice farm and fenced forest range. Southwest Louisiana.	Fenced forest range and rice fallow.	July—fenced forest range and rice fallow. Aug.-Sept. — improved pastures.	Oct.—improved pasture. Nov.—rice field gleanings. Dec.—fenced forest range and rice fallow.	Fenced forest range and rice fallow; rice straw stacks. Weak cows and heifers with 100 days' supplement, 1 lb. cottonseed meal and 3 lbs. hulls.	74	350	1.6
Farm and leased forest range, fenced. Northwest Louisiana.	Entire herd on fenced forest range.	Entire herd on improved farm pasture.	Oct.—field gleanings. Nov. —improved pasture. Dec. —fields with 2 lbs. hay per head per day.	Fields including oats cover crop. 90 days' supplement with 1 lb. cottonseed meal and 8 lbs. hay.	74	350	3.0
Farm and leased forest range. Delta.	Improved farm pasture.	Fenced forest range and unimproved pasture.	Main herd on fenced forest range and unimproved pasture. Cows with fall calves on improved pasture, and 15 days' supplement 2 lbs. cottonseed cake after Dec. 15.	Part on forest range, part on improved farm pasture, 90 days' supplement 2 lbs. cottonseed cake.	69	350	1.9
Fair nutrition:							
Farm and free range. Southeast Louisiana.	Free pine forest range.	Free forest range.	Oct.—free pine forest range. Nov.-Dec.—crop and hay field gleanings.	Fenced bottomland hardwoods range and unimproved pasture. 60 days' supplement, 3 lbs. ear corn (ground) and 4 lbs. hay.	58	350	2.7
Poor nutrition:							
Farm and free forest range. Delta.	Free forest range.	Free forest range.	Free forest range.	Field gleanings and oats cover crop. 90 days' supplement ½ lb. cottonseed meal and 5 lbs. hay.	40	300	9.1
Farm and free forest range. Southeast Louisiana.	Free forest range.	Free forest range.	Free forest range.	Main herd on free forest range with no supplement. Weak cows on fields and unimproved pasture with 90 days' supplement, 1 lb. cottonseed meal and 2 lbs. hulls.	37	275	5.7
Farm and free forest range. Northwest Louisiana.	Free forest range.	Free forest range.	Free forest range.	Main herd on free forest range. 60 days' supplement with 1 lb. cottonseed meal. Hospital bunch on field gleanings with 2 lbs. cottonseed meal and 3 lbs. hulls.	36	325	4.8
Yearlong free forest range. Southwest Louisiana.	Free forest range.	Free forest range.	Free forest range.	Main herd on free forest range. 60 days' supplement, ½ lb. cottonseed meal and 2 lbs. hay.	35	300	6.4

Louisiana cattlemen are fortunate in having trees on their ranges to provide protection from excessive summer heat. About 71 percent of the farmers mostly with small herds stated that they have sheds of some sort to provide winter shelter in case of severe, cold storms, for a few weak animals. Twenty-nine percent depend entirely on thickets and trees for winter shelter. Many farmers, however, stated that they realized that their livestock would require less feed and come through the winter in much better condition if they were better protected from cold, wet weather. Farmers in northern Louisiana, where the weather is colder, naturally make somewhat better provision than those in the southerly parts of the State.

Louisiana is blessed with abundant natural water in creeks, bayous, holes, and springs. Some 91 percent of the farmers interviewed depend upon natural water. Six percent furnish livestock water from wells at the farm home. The 1943 drought forced attention to the importance of a good water supply, because in many localities livestock water was scarce, and of poor quality. Clean, cool water is relished by cattle fully as much as by humans. Many stockmen felt that their cattle would do better if improved water supplies were available, particularly through stock ponds and reservoirs fenced apart and made available to the cattle in troughs.

Although practically all of the farmers interviewed furnish their cattle with supplemental feed at some time during the winter, only 55 percent reported that they were equipped with adequate feeding troughs in which to place the feed and to insure its efficient use by the cattle. Good troughs for concentrates and racks for hay are two of the many improvements that will pay out quickly through more economic use of feed. Salt placed in boxes under shelter is also good practice to avoid loss during heavy rains. Several farmers had silos, usually in connection with dairying operations, but only one farmer was using his silo for putting up beef cattle feed.

Only 4 percent of the farmers indicated that they had scales available for weighing their cattle. Twenty-five percent said that dipping vats were available, but only 12 percent reported that they have been used since the dipping campaign for eradication of cattle fever ticks several years ago. Community efforts to recondition or install and use dipping vats at least once or twice a year to control ticks and lice on cattle would undoubtedly be worthwhile.

HANDLING LIVESTOCK

Most Louisiana stockmen handle their cattle, if they own any great number, in true ranch style. They usually castrate, brand, mark, and dehorn in early spring or late fall in order to avoid chances of severe screwworm infestations. With most calves coming in early spring, they are as a rule worked over before the herd is turned out on forest range.

Seventy-six percent of the farmers interviewed reported that they castrate calves in the spring, 6 percent in the fall, and 18 percent do not castrate calves at all or have no regular time, usually because calves are marketed early. Seventy-four percent of the farmers brand their calves in the spring at the same time steer calves are castrated. A few farmers mark their cattle but do not brand; 14 percent do not brand or mark regularly, usually because the animals are under strict control in fenced pastures. Cattle brands and marks should be more effective under the new state livestock brand commission provided for by the Louisiana State Legislature in July, 1944. Thirty-three percent dehorn their calves, 5 percent have polled bulls, and 62 percent do not dehorn regularly. About half dehorn only yearling heifers held over for herd replacements.

Improved methods of handling cattle are gradually being adopted, largely because the better quality of animals and the increased prices received warrant good care with a minimum of bruising and damage to meat and hides. Large herds usually are handled on horseback, frequently with the aid of dogs. Selected cows on free range are frequently belled for easy location.

MARKETING

Marketing beef cattle is the pay-off. The farmers interviewed sold more than 3,300 animals during the year, amounting to about 15 percent of the cattle on hand at the time of interview. Many planned additional heavy marketings before the end of 1943, shortly after the interview. Those sold were predominantly calves and yearling steers, although because of feed shortages many operators culled their herds rather closely and sold some heifer calves and old cows. An increasing number of farmers are selling calves for veal or baby beef in order to get them off of the cows when they are fat and allow the cows to come through the winter in better shape than if a large calf remained at side. Nearly one-third of the farmers reported they had slaughtered one or more beef animals for home use.

The system of local livestock auction sales, now rather well distributed throughout Louisiana, is enabling farmers to dispose of their marketable cattle when in the best condition and on short notice when prices appear reasonable. In general, experienced stockmen have found it preferable to market offspring regularly every fall, culling herds more closely in times of feed scarcities such as 1943. This eliminates the cost of excessive winter feeding, assures a dependable production of beef each year, and a regular income to the farmer. Marketing range cattle in the best condition is strongly urged by the U. S. Department of Agriculture as sound practice to take full advantage of cheap gains in weight during the green forage season.[15]

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[15] Market Your Range Cattle in the Best Condition. U. S. Dept. Agr., Forest Service. AWI-55. 1943.

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This big calf went to market! A good beef type steer calf that should go to market immediately, permitting the cow to winter in good condition and bring another calf the next year. Forest range in northwest Louisiana. Photo Oct. 14, 1943.

CATTLE GRAZING AND FORESTRY

Louisiana's 16.2 million acres of forest land are 96 percent in private ownership, with about one-fifth in farm woodland. The cost or value of the forest products from these lands is around 100 million dollars per year, a major industry and source of income to the people of the State, including farmers. However, a recent survey by the U. S. Forest Service indicated that Louisiana's forests are in general greatly understocked with trees, growing wood products at less than half their potential capacity. Therefore managed cattle grazing on forest range must take into account those practices and customs which affect this vast forest industry. These include such benefits as fire hazard reduction and possible damage to trees from woods burning and grazing.

Forest Range Burning

Farmers' opinions regarding range burning vary considerably in different parts of Louisiana. In many northwest parishes, in the eastern Florida Parishes, and throughout most of the Delta, farmers protect their own woodlots from fire and do not like to see the open range burned. More than half the farmers reported that they had no major fires in the past 4 or 5 years (Table 9). In fact, the LaSalle Parish Cattlemen's Association in 1943 offered "$100 reward to anyone furnishing information leading to the arrest and conviction of any person maliciously causing a forest fire in LaSalle Parish." Stockmen in this parish generally carry their animals through the winter on forest range and dislike to see the forage burned off, as it is valuable roughage. On the other hand, in the central Florida Parishes and over much of southwest Louisiana, it is customary to burn over the range during the fall, winter, or early spring. Various reasons are given for these fires; many of them are in connection with sheep range, to make available the fresh, green growth. Other explanations are given, such as eradicating ticks, snakes, redbugs, keeping down brush, and exposing stumps for hauling to chemical wood plants. The sentiment expressed in favor of fire protection was particularly noticeable in areas where action agencies such as the State Division of Forestry, the United States Forest Service, the Soil Conservation Service, or others have been urging and demonstrating fire protection for the past few years.

TABLE 9.

OCCURRENCE OF FIRES ON FOREST RANGES USED BY FARMERS SURVEYED

FREQUENCY	North-west	South-west	Florida Parishes	Delta	TOTAL
	NUMBER OF FARMS				
Annually	4	15	11	2	32
2-3 years	9	1	1	1	12
4 or more years	32	15	10	17	74
TOTAL	45	31	22	20	118

The farmers interviewed were almost unanimous in stating that uncontrolled fires damage trees, both young seedlings and frequently the larger trees. Thus winter and spring fires in some areas entirely wiped out the abundant tiny longleaf pine seedlings resulting from the exceptional 1943 seed crop. Eighty percent of the farmers felt that accidental burning also has a bad effect on the forage (Table 10). The main effects cited are in removing herbage needed for cattle grazing, in favoring the growth of less palatable and shorter-season plants and in exposing the soil to serious erosion, particularly in the hill lands of northwest Louisiana. Fifteen percent of the farmers said that uncontrolled burning was beneficial to the forage, particularly in ridding the range of excessive rough and permitting animals to secure fresh, green forage in the spring.

Some 20 farmers familiar with controlled burning in the longleaf pine belt were all of the opinion that it is a good practice in that type, where it can be used when needed to reduce the rough, avoid the danger of excessive damage from uncontrolled fires, and control brown-spot disease on pine seedlings. There is good experimental and administrative experience to back up the cautious use of "prescribed burning" in the longleaf-slash pine type.

An experiment in the longleaf pine flatwoods at McNeill, Miss., showed that annual burning improved the forage conditions for cattle but seriously retarded the growth of longleaf pine saplings. The results indicate "that successful regeneration of longleaf pine, especially where

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Native cattle in early winter on a recently burned free forest range in southwest Louisiana. The fire destroyed valuable roughage needed by the cattle for winter, and killed newly germinated pine seedlings. Photo Dec. 8, 1943.

brown-spot disease is epidemic, may depend upon some system of periodic controlled burning rather than the extremes of annual fires or fire exclusion . . ."[16]

TABLE 10.

FARMERS' OPINIONS ON EFFECT OF ACCIDENTAL FIRE ON FORAGE

Effect	Northwest	Southwest	Florida Parishes	Delta	Total
	Number of farmers				
Beneficial	7	5	5	1	18
Detrimental	37	24	16	17	94
No effect	1	2	1	2	6
Total	45	31	22	20	118

Widespread burning is not advocated because of the danger of allowing a fire to escape or do serious damage unless it is done under very carefully prescribed conditions of weather, forage plant maturity, and tree growth. A farmer naturally does not want to burn a good pasture; neither does he want to burn an area that can bring him a return of $2 or more per acre per year from trees, if well stocked and under intensive management. Therefore fire should be used only under the strictest conditions of control.[17]

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[16] Wahlenberg, W. G.; Greene, S. W.; and Reed, H. R. Effects of Fire and Cattle Grazing on Longleaf Pine Lands as Studied at McNeill, Mississippi. U. S. Dept. Agr. Tech. Bul. 683, 52 pp., illus. June 1939.

Prescribed burning is not recommended outside the longleaf type because of damage to the trees.

Burning poses a problem to farmers who graze their cattle in the forest during winter and spring. As one stockman put it, he had to remove his cattle from a pasture where an accidental burn had occurred because they "would stand around on the burned area during the early spring looking at the short green grass and starve to death." His words are literally true, as shown by measurements taken on the Kisatchie National Forest in Grant Parish in the spring of 1944. On March 1, areas burned in midwinter supported only about 100 pounds of green growth per acre, representing 30 to 40 pounds of dry weight per acre. Furthermore, the grass was so short as to make it practically impossible for the cattle to obtain a fill. Unburned range on the same date had a combined dry herbage and green growth of approximately 1 ton of grass per acre which, with supplemental feeding of concentrates to fill out the diet, furnished a reasonably good source of roughage during this critical period. By April 1, of course, there was ample forage growth for grazing on the burned area.

Additional experiments are needed to work out the effect of fire on forage and on cattle gains, on the conditions under which controlled burning might be used, and on the use of fire in checking brush and noxious species.

Cattle Damage to Trees

One of the most important questions in grazing forest range is possible damage to the trees by livestock. The farmers interviewed were almost unanimous in the opinion that cattle do not damage large trees and that they usually do only negligible damage to pine seedlings, unless forage is very scarce. Cases have been observed in small pastures grazed closely where cattle pull the needles and nip the buds of young pines. However, on large areas of forest range where there is plenty of grass, especially when grazed during spring and summer, such serious injury to pine seedlings has been lacking.

On the other hand, cattle undoubtedly damage seedlings of valuable hardwood species if left on the range during early spring when young, tender shoots are growing and new seedlings are easily harmed. Plots were observed in the Ouachita Cone where grazing was heavy during

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[17] Bickford, C. A., and Curry, John R. The Use of Fire in the Protection of Longleaf and Slash Pine Forests. Southern Forest Expt. Sta. Occasional Paper No. 105. 22 pp., illus. Aug. 15, 1943.

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Cattle grazing on firebreak carefully burned over in winter. Kisatchie National Forest, central Louisiana. Animals were in good shape because they were being fed adequate supplemental feed. Photo Feb. 24, 1944.

winter and early spring until the grass greened up. The areas showed less than one desirable seedling per acre. In Livingston Parish where grazing is done the year round, but with less intensity, observations showed severe hedging of ash and poplar seedlings because of cattle grazing. These seedlings were confined to a height of 1 to 3 feet and had up to 4 main branches rather than a single straight stem. Thus the question of cattle damage to tree reproduction appears to be much more serious in hardwood stands than in the pine belt. Even in the hardwoods, however, observations indicate that the working out of more suitable grazing seasons might eliminate much of the injury, especially if ranges were stocked to proper grazing capacity of the grass and herbaceous forage available. However, definite recommendations must await further study.

The damaging of trees by livestock is particularly serious in the small farm woodlot. Such use does not deserve to be called grazing, because the area is usually so small and the forage so scanty that the farm woodlot serves more as a "stomplot" or for shelter from excessive heat or severe cold rather than for grazing. Every farm at times has need for posts, poles, fuel, and lumber, most of which can be obtained from the farm woodlot if carefully managed. Both forestry agencies and farmers who recognize the potential yield of forest products and cash income, even from a few acres of farm woodlot, agree that it should be protected from both fire and overgrazing.

Forest Grazing Reduces Fire Hazard

Many farmers point out that far from actually damaging the trees, careful cattle grazing really benefits the forest. Twenty-two percent of those interviewed felt that grazing reduces the competition to the trees from grass and brush for moisture and needed plant nutrients. The main benefit, however, is in reducing the rough to such an extent that less fuel remains to cause serious damage to the trees in case of fire (Table 11). Eighty-eight percent of the farmers interviewed estimated that grazing reduced the fire hazard more than 10 percent, while nearly a third felt that the reduction is more than 30 percent. Estimates of hazard reduction varied all the way from 0 to 80 percent, the average for all farmers interviewed being 27 percent reduction. This wide range of estimates seemed related to the concentration of cattle and the type of forage available. In areas where the cattle stocking was high and in woods which had few open grassy spots the hazard reduction was greatest. Several years' accumulation of rough in one pasture on the Kisatchie National Forest was reduced to a negligible fire hazard by a few months' heavy grazing with cattle, according to former Supervisor W. R. Paddock.

These estimates of fire hazard reduction are well founded. Actual measurements of the weight of grass material in central Louisiana in March 1944 showed that there was less than 40 percent as much fuel on a grazed area as on one with several years' ungrazed rough. Over a period

Cattle grazing on this cutover longleaf pine forest obtain good spring, summer, and fall grazing from native grasses, help keep down the fire hazard, and do no perceptible damage to the longleaf pine seedlings. Also they return an income to help carry maintenance costs while the young pines are growing up. Central Louisiana. Photo Oct. 20, 1943.

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of years, this reduction in fire hazard is brought about not only in the actual removal of forage by the grazing animals, but also in changing the stand of the vegetation to a less hazardous type. Thus fairly close grazing tends to kill out the tall-growing species of rough, such as broomsedges and wiregrass, and encourages the spread of the low-growing plants such as carpet grass, Bermuda grass, and lespedeza.

Prolific growth of blackjack oak and other undesirable hardwoods competes with valuable pines and shades or smothers the grass, impeding both forest management and grazing, especially in northwest Louisiana. Close grazing may check some of these poor tree species, but appears to have only slight effect on the scrub oaks. These pest species have been poisoned or girdled in some forestry operations, but only at considerable expense.

TABLE 11.

REDUCTION OF FIRE HAZARD BY CATTLE GRAZING ESTIMATED BY FARMERS INTERVIEWED

REDUCTION	North-west	South-west	Florida Parishes	Delta	TOTAL
PERCENT	NUMBER OF FARMERS				
Over 50	3	0	1	4	8
31-50	11	5	8	5	29
11-30	25	23	11	8	67
10 or less	6	3	2	3	14
TOTAL	45	31	22	20	118
	PERCENT				
Average reduction	26	22	30	36	27

Another important problem in the combined use of land for trees and grazing is the gradual decrease of forage resulting from the shading and competition by the trees as they grow to maturity. Farmers interviewed estimated that the reduction in grazing capacity from this cause amounts to about 3 percent per year, or an average curtailment of one-third in 11 years. This is more serious in the shortleaf-loblolly-hardwoods type where the forest stand is somewhat more dense than in the more open longleaf-slash pine types. The problem can be met in various ways, depending on the individual setup. In some cases, particularly free range operations, it means reduction in herd numbers to a more productive basis, shifting livestock more to improved pasture. Under intensive forest management, with thinning of pine stands to proper spacing each 5 or 6 years, a fair stand of forage can be maintained. When proper spacing is maintained a stand of forage can be grown, even in loblolly-shortleaf stands, sufficient to use as a supplement to improved pastures. Therefore, by planning the forest operation carefully, with practical concessions both in grazing and in timber production, enough of an open stand can be kept on parts of the area to provide range for the animals during the season when it can be grazed to best advantage. However, much study is needed to work out such details of cattle grazing in relation to intensive forest management so as to obtain the greatest return from the land in the form of forest products and meat.

Cattle Grazing and Forest Farming

One farmer in northwest Louisiana owns some 850 acres on part of which he has grown cattle for 30 years, at the same time protecting the area from fire. Two-thirds of the area is in trees with about 250 acres under good forest management. In the past 6 years this forest has yielded an average of nearly $1,000 per year from selective cuttings of shortleaf and loblolly pines. Other farmers with 40 to 80 acres were devoting a few acres to growing trees, and raising cattle at the same time. Grazing should be carefully controlled, of course, on these smaller farm woodlots. On larger acreages, range cattle raising offers one means for meeting carrying charges while the area devoted to forest is being brought to full productivity through fire protection, improvement cuttings, thinnings, and planting.

RÉSUMÉ OF FOREST RANGE PRODUCTION PROBLEMS

Each of the farmers interviewed was asked to name his most important problems of cattle raising and forest land management. By far the greatest number, 89 percent, indicated that wintering their animals was one of their most important range problems. Phases of this question involve many combinations of forest range, supplementing with concentrates, and winter pasture peculiar to individual farms. Half of the farmers indicated the need for improved pastures to supplement the forest range as a problem of primary concern. Twenty-nine percent stated that they needed improved forest range management practices, particularly information on season and intensity of grazing forest range and the problem of the trees shading out the grass. Other important problems were control and prevention of disease, improved breeding of animals suitable for forest range, fenced control of additional land through either ownership or lease, adequate wartime labor and materials, and better marketing facilities, including needed sanitation measures at local auctions.

The outstanding forest land problem mentioned was protection from fire, 65 percent of the farmers listing this as an important question. Twenty-seven percent wanted better information on managing their farm woodlots or forest tracts. Twelve percent said they needed more land, and 9 percent needed better control of the forest land on which their cattle grazed. Other outstanding forest problems included better information on marketing and natural reforestation.

Practically all of the farmers interviewed were vitally interested in forest range management. They felt that range livestock have a real future in Louisiana because of the relatively long season of worth-while low-cost grazing on forest land, and most of them plan for sustained, better-managed, and more profitable beef cattle operations in future years.

SUMMARY

Louisiana's 16 million acres of forest land furnish substantial forage to beef cattle, as indicated by a survey in 1943 of 118 farms where cattle are grazed on forest range. The survey was concerned primarily with the pine types and covered 34 parishes, including northwest Louisiana, southwest Louisiana, the southeast or Florida Parishes, and parts of the Delta hardwoods along the Mississippi and Red River valleys. Native forage in these types includes mainly the bluestems or "broomsedges," three-awns or "wiregrasses," panic grasses, paspalums, and the like, along with the naturalized carpet grass and, in the northern part of the State, Bermuda grass also on the more closely grazed areas. Because more than half of the State is in forest land and a comparable proportion of the farms surveyed is in trees, forest grazing is a definite part of the cattle-raising industry in Louisiana, but one which has been given little attention.

The purpose of the survey was to find out what improved practices farmers are using to secure better beef cattle production from forest ranges, and their main problems needing experimental work, particularly to attain better coordination of grazing with good farming and forestry. Sixty-four percent of the operators interviewed use free range. Fenced control of forest range appears on the increase, mainly by landowners, but also through nominal leasing arrangements between timber companies and local resident farmers.

Forage in the pine types apparently is best mainly during spring and summer. However, more than half of the herds surveyed graze in the forest yearlong, particularly where there is a desirable combination of pine forest range for spring and summer with bottomland hardwoods range for winter. Sixty-nine percent of the yearlong sustenance of herds surveyed was secured from forest range. Less forage was secured in north Louisiana, where the shortleaf-loblolly pine-hardwood stands are more dense than in the southwest and Florida Parishes where the longleaf and slash pine stands are more open.

Farm pastures are furnishing an increasing amount of forage—and large additional acreages are needed, particularly for the midsummer dry period and during winter when pine forest ranges furnish little real forage. Field crops after harvesting, mainly corn and hay fields, are used to finish off calves and other market animals for sale, and to start the breeding herd into the winter in good shape. The common practice is to feed cattle a supplemental concentrate such as cottonseed meal, along with hulls, throughout the worst winter months, usually from January to March inclusive, although the average ration appears to be a subsistence rather than a maintenance ration. Few farms reported dry-lot feeding, either for maintenance or for fattening. Most cattlemen salted their cattle regularly, but only 29 percent furnished mineral supplement to prevent or cure the creeps and other mineral deficiencies.

Most of the herds studied on forest range were either good-grade beef cattle or mixed grade and native. In parts of the State, particularly the Florida Parishes, it is common practice for dairy herds to graze on forest range during much of the year. About 90 percent of the farmers interviewed are now practicing herd improvement, although the majority have taken up the practice within the last decade, particularly since the State was freed from cattle fever ticks. Bulls generally are either purebred or grade beef type, although indications are that more bulls and a better distribution among the cows during the breeding season would aid in a worthwhile increase in calf crop. Calf crops reported in this study for 1943 were 50 percent, somewhat higher in north Louisiana, and lower in the southwest. These figures are below the average for the State, but this is to be expected of outfits grazing on forest range where control and care of animals cannot be as good as in farm pastures. Death losses are rather high, and include such causes as starvation, railroad and highway accidents, bogging and drowning, disease, poison plants, and theft. Minor pests such as screwworms, stomach worms, grubs, ticks, and lice cause few death losses but are a drain on livestock production that should be greatly reduced by better care.

Livestock handling facilities such as good, clean water, shelter against summer heat and winter cold, and boundary and cross fences, corrals, and feeding equipment are admittedly inadequate for perfect care of the animals, but with better quality livestock and higher prices, better facilities are gradually being installed. Handling practices, such as castrating, dehorning, branding, and marking, are usually timed to avoid screwworms, although some stockmen market their calves early enough in the fall to avoid the necessity of these practices.

Most of the farmers interviewed oppose uncontrolled burning of forest range, feeling that it damages both the grass and the trees. Those who are familiar with controlled burning, however, felt that in the longleaf pine type it benefits the grazing and is helpful in forest management. Where ranges are properly stocked, or moderately stocked, cattle appear to do little damage to pine seedlings, although they may damage hardwood seedlings, especially during spring when buds are tender and growing. On the other hand, cattle grazing reduces the competition to the trees from grass and brush, and also reduces the fire hazard. The farmers interviewed estimated an average of 27 percent reduction in fire hazard from forest grazing.

The average small farm woodlot appears to be used by so many animals for summer shade and winter protection that it furnishes little or no forage and is far below its possible forest production. Maximum returns from these areas can be obtained only by eliminating the grazing or limiting it to actual forage values, and practicing constructive forestry.

Most important forest range problems of farmers interviewed are: wintering the cattle breeding herds, involving both supplemental feeds and improved pastures; improved forest grazing management, including season of use and grazing capacity; disease control; improved-quality animals; and land control. All of these are worthy of intensive study.

Most pressing forestry problems listed by farmers were fire protection, forest management, need for more land, and better land control.

SUGGESTED PRACTICES

Following is a summary of important practices based on experiences of farmers in this survey and suggested where forest grazing is practicable in connection with good forest and farm management by the Louisiana Agricultural Experiment Station and Extension Service; the Forest Service, the Bureau of Animal Industry, and Bureau of Plant Industry, Soils and Agricultural Engineering of the U. S. Department of Agriculture; and the State Division of Forestry. The publications cited should be referred to for more complete information.

Forest Range Management

1. Plan the best use of forest range in the farm, livestock, and forest operations, as indicated below.

2. Work out the best season of forest range grazing in the yearlong feed supply, and see that breeding animals receive at least a maintenance ration throughout the year. Although detailed experiments are needed, the best season of grazing pine forest range appears to be spring and summer and, in some cases, early fall.

3. Carefully adapt the kind and class of animal to the forage available. Breeding cows of the beef type usually do well on forest range when the forage is of sufficient abundance and quality for them to secure a fill.

4. Turn cattle out on forest range only after they are sure to have plenty of green, nutritious forage.

5. Check the range for poisonous plants such as Carolina jessamine and buckeye to avoid unnecessary death losses.

6. Carefully adjust the number of animals to the grazing capacity, i.e., to the forage available particularly on fenced range, so the animals will have plenty to eat at all times, without serious damage to forage, trees, and soil.

7. Furnish adequate supplemental feed to maintain cattle in good condition if they must be run on forest range in winter.

8. Plan distribution of animals over the range so as to make as even utilization of the forage as possible, avoiding local overgrazing in some spots and waste of forage in others. Adequate fencing, watering, and salting places and other facilities are essential.

Animal Husbandry

1. General rules—grow a good grade of livestock, feed them well, and keep them healthy.

2. Use the best females available adapted to local forest range conditions. Use a good purebred bull of a preferred breed. Do not breed heifers until they are long yearlings or early two's.

3. Cull the herd closely each fall to eliminate old or barren cows.

4. Sell calves in fall when fat unless ample feed is available for wintering them.

5. Winter the breeding herd with enough supplemental feed to maintain vigor and vitality, usually requiring 60 to 100 days.

6. Provide mineral mixture adapted to local needs.

7. Vaccinate regularly to prevent occurrence of such diseases as blackleg, anthrax, and Bang's disease.

8. Handle animals with care to avoid damage to a valuable product. See Louisiana Extension Circular No. 225, "Beef Cattle—Herd Improvement." Also "The Louisiana Farmers' Almanac—1944."

Improved Pastures

1. Select good land.

2. Prepare the land by ridging and terracing if needed, adding organic matter, supplying lime and fertilizer.

3. Seed to appropriate mixtures of grasses and legumes needed to round out the year's forage and feed supply.

4. Maintain pastures by rotation grazing, mowing; avoid overgrazing and renovate when necessary.

5. Supplement permanent pastures with temporary pastures needed particularly for winter grazing and for midsummer dry season grazing. Lespedeza, Dallis grass, Allyce clover, sudan grass, and kudzu all furnish good summer grazing. Oats and ryegrass are good for winter grazing, although requiring supplements. Clovers are good for early spring, before

forest range is ready. See Louisiana Extension Circular No. 248, "Pasture and Feed."

6. Feed crops. Grow enough feed crops, such as corn, hay, or purchase supplements needed for wintering the breeding herd.

Forest Management—the Farm Woodlot

1. Prevent forest fires—it pays.

2. In the longleaf pine type, if grazing has been so light as not to keep down the rough, and there is danger of a conflagration in your woodland from an accidental fire, it may be practical to control-burn to remove the rough, to control brown-spot disease, or to furnish fresh, easily accessible forage for the livestock. Experienced foresters recommend careful selection of the area to be burned so as to avoid excessive damage to pine reproduction; burning in the evening, usually after sunset, when wind conditions are stable and moisture of the fuel is slowly increasing; burning against the wind, usually with velocities of 5 to 10 miles per hour, with high relative humidity. Burning in Louisiana should be done during the dormant season from about November 15 to March 15. Foresters prefer not to burn the same area more frequently than about every 3 years. Careful preparations are necessary to keep such fires strictly under control, and at a moderate cost. Check with the nearest State or Federal forest official to be sure of local regulations regarding fire. See Southern Forest Experiment Station Occasional Paper No. 105, by Bickford and Curry.

For types other than longleaf, controlled burning is not recommended. Fire is too injurious to the other tree species to permit its general use in forest management.

3. Timber stand improvement. Cut out or deaden undesirable species such as scrub oaks, using them for fuel, posts, or chemical wood; build up the sawtimber growing stock by improvement cuttings so as to realize the greatest possible growth and income. Individual merchantable trees should be selected and marked. In ordinary times farmers can cut their own timber products and sell them at a better price than they can dispose of the stumpage.

4. Eliminate grazing damage in small farm woodlots. Keep grazing under carefully managed control in large woodlots or commercial timber operations to avoid damage to trees. See U. S. Department of Agriculture Farmers' Bulletin No. 1177.

When you need help, see your county agent. He will give you the needed information or put you in touch with technical action, extension, and research agencies qualified to help you with forest range management, beef cattle management, improved pastures, farm feed crops, or growing trees for profit and income.

COMMON AND SCIENTIFIC NAMES OF RANGE PLANTS MENTIONED

Bermuda grass	*Cynodon dactylon*
Blueberries	*Vaccinium* spp.
Bluestems, "broomsedge" grasses	*Andropogon* spp
Buckeyes	*Aesculus* spp.
Carolina jessamine	*Gelsemium sempervirens*
Carpet grass	*Axonopus compressus*
Gallberry	*Ilex glabra*
Huckleberries	*Gaylussacia* spp.
Lovegrasses	*Eragrostis* spp.
Maidencane	*Panicum hemitomon*
Muhly grasses	*Muhlenbergia* spp.
Palmettos	*Sabal* spp.
Panic grasses	*Panicum* spp.
Paspalum grasses	*Paspalum* spp.
Switch cane	*Arundinaria tecta*
Three-awns, "wiregrasses"	*Aristida* spp.
Viburnums, "haws"	*Viburnum* spp.

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RICE AND THE VITAMIN B COMPLEX

by

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RICE AND THE VITAMIN B COMPLEX

By VIRGINIA R. WILLIAMS AND E. A. FIEGER

The cereals—botanically, those grains and seeds of the grass family—have been the chief food of mankind for centuries. As late as the Roman era the goddess Ceres, for whom "cereals" were named, was deeply revered as the special guardian and benefactress of the grain. Each civilization has been characterized by the cultivation of one particular grain crop—wheat having become the "staff of life" of the Western world, just as rice has been the mainstay of Oriental peoples. In this hemisphere a like esteem for rice has been shown by the populations of Louisiana and neighboring states as well as Cuba and Puerto Rico, where large quantities of rice are consumed annually.

Since the germ and bran layers are removed by customary milling operations, rice is usually consumed in the "polished" state, although scientists have known for the last quarter-century that the better recognized B vitamins were located principally in these removed portions. The findings of vitamin research have prompted many endeavors to discover dietary uses for rice polish and rice bran as well as aroused questions with regard to the influence of variety and milling on the content of the newer B vitamins. In the attempt to answer some of these questions, this investigation was undertaken.

At the present time at least eleven substances are recognized as B vitamins: thiamine or B_1; riboflavin or B_2; niacin or nicotinic acid; pantothenic acid; pyridoxine or B_6; biotin; inositol; choline; para aminobenzoic acid; and two folic acid factors, B_{10} and B_{11}. Although only the first three of these eleven compounds are definitely known to be needed for human nutrition, the analyses undertaken here included also pantothenic acid, pyridoxine, biotin, and inositol in the event that later work might prove these vitamins necessary to man. The functions of the B vitamins as far as they are now known are given below.

Thiamine or Vitamin B_1 was the first B vitamin to be recognized and isolated and, for that reason, the clinical picture of functions and deficiency symptoms is now practically complete. Thiamine is needed by the body in its use of starch and sugars derived from the diet or made in the body. When an individual lacks thiamine, the emotions are affected first —and later, the nervous system. Loss of appetite, a feeling of fatigue, digestive disturbances, muscular weakness, pains in arms and legs, swelling in ankles and face, and lowering of blood pressure indicate the onset of B_1 deficiency. In more severe cases, the entire nervous system is affected, resulting in what is called "polyneuritis" and "neuralgia." Frequently the muscles in the calves of the legs will cramp and at a later stage, loss of use may occur. "Beri-beri," the name applied to conditions of severe lack of thiamine, is recognized by such symptoms as lameness, lack of muscle coordination, disturbance of the nervous system followed by labored breathing, overgrowth of the right side of the heart, and finally, death from heart failure.

Riboflavin, or B_2, regulates the speed of certain chemical reactions of the body, assists in the body use of starch and sugar, and functions in the seeing mechanism of the eyes. Individuals who consume diets inadequate in riboflavin develop a condition known as "cheilosis," characterized by sores on the lips and in the corners of the mouth, a scaly greasy condition around the folds of the nose, and inflammation of the tongue. Roughness, itching, and burning of the eyes as well as a sensitivity to light may also occur.

Niacin or nicotinic acid, like riboflavin, assists in the body's chemical reactions and helps to transport hydrogen through the system. Unlike thiamine, slight niacin deficiency cannot be recognized by any characteristic symptoms. After long deprivation, a drop in the blood level of niacin as well as the onset of "pellagra" are the first indications of niacin hunger. A definite type of sores appear in the mouth and on the skin over the nose, forehead, hands, wrists, elbows, knees—in fact any part of the body exposed to sunlight and friction. Many persons suffering from pellagra experience digestive disturbances, loss of appetite, and diarrhea. Continuance of the illness results in mental disorders—clouding of the mind, uncontrollable grasping of the hands, rigidities, and finally death. Persons developing pellagra are ordinarily on such poor diets that they lack vitamins other than niacin, but niacin appears to be the principal deficiency.

Recent work indicates that *pyridoxine* may be needed in the diet of human beings since it appears to help in curing some cases of muscular weakness, nervous disorders, acne, and nausea of pregnancy. Pyridoxine deficiency produces "rat pellagra" in rats, and results in convulsions in dogs, chicks, and pigs. *Pantothenic acid* is needed by chicks for normal feathering and good skin condition. It prevents gray hair in rats, but so far has not been shown to exercise the same function in human beings. Rats and mice need *inositol* for normal growth and production of hair, as well as for the maintenance of normal liver condition. Graying of hair in rats results from lack of *para aminobenzoic acid,* but there is no conclusive evidence that it serves the same purpose in human beings. *Biotin* hunger produces in rats a characteristic skin trouble, graying of the fur, and loss of hair around the eyes, resulting in "spectacled eye." The bottoms of the feet of chicks that are biotin deficient become rough and calloused and may in more severe cases become encrusted and bleed. A human being on a diet containing large quantities of raw egg-white develops symptoms known as "raw egg-white injury" which are relieved by feeding foods containing biotin. Biotin is sometimes helpful in curing cases of acne and skin eruptions in human beings. *Choline* is undoubtedly used by animal bodies as a building unit and may help regulate the body use of fats. It is definitely needed by rats, dogs, rabbits, guinea pigs, chicks and other animals, but human needs have not yet been investigated. *Vitamins B_{10} and B_{11}* are needed for normal feathering in chicks and for the prevention of anemia.

Experimental Work

In September of the 1942-43 milling season, laboratory workers collected one hundred rice samples from 13 Louisiana mills and one Arkansas mill. The collection of samples from many mills rather than one mill was held desirable in order to obtain data representative of milled samples in general. Samples of rice were collected and examined during the 1941-42 milling season, but the results of those anlyses were used for preliminary study only. The samples were divided into two main groups: (1) samples of brown rice of six outstanding Louisiana varieties (Blue Rose, Fortuna, Early Prolific, Nira, Rexoro, and American Pearl) collected for the purpose of studying differences among varieties, and (2) samples of milled fractions of three typical varieties (Blue Rose, Early Prolific, and Fortuna) for the purpose of studying differences in vitamin content of the different milled fractions.

These milled fractions consist of the products obtained through the different operations in the milling process, as more and more of the outer coats of the rice grain are removed and the rice progresses from the original rough state to the finished product. In Louisiana, the fractions usually consist of: (1) brown rice, (2) first break rice, (3) second break rice, (4) brushed rice, and (5) finished rice. The by-products of the milling process are (6) rice polish and (7) rice bran, which may also be considered milled fractions and consist of the removed outer coats of the grains.

The samples were analyzed by a combination of chemical and microbiological methods. Thiamine, riboflavin, and pyridoxine were determined chemically; and the other vitamins, microbiologically. Further information on these methods will be furnished on request by the Department of Agricultural Chemistry and Biochemistry, Louisiana State University.

The influence of variety on vitamin content is shown in Table I and that of milling in Table II. As may be seen, no outstanding differences

TABLE I

COMPARISON OF THE VITAMIN CONTENT OF SEVERAL VARIETIES OF BROWN RICE

VARIETY	VITAMIN CONTENT IN MICRO-OUNCES PER POUND*						
	B_1 Thiamine	Niacin	Pantothenic acid	Pyridoxine	B_2 Riboflavin	Biotin	Inositol
Blue Rose..........	64.0	788.8	264.0	150.4	12.1	1.8	61,184.0
Early Prolific.......	67.2	728.0	254.4	164.8	9.0	2.0	50,224.0
Nira..............	83.2	966.4	276.8	163.2	8.4	2.0	46,496.0
Rexoro............	68.8	668.8	246.4	171.2	8.7	2.1	40,848.0
American Pearl.....	57.6	625.6	233.6	166.4	7.9	1.9	38,496.0
Fortuna...........	70.4	750.4	297.6	179.2	8.3	2.0	65,840.0
COMPOSITE AVERAGE.	68.5	754.7	259.1	165.9	9.1	2.0	50,514.7

Daily allowances for moderately active man recommended by Nat'l Research Council	B_1—63.49 micro-ounces. Niacin—634.92 micro-ounces. B_2—95.24 micro-ounces.

*Micro-ounces = one millionth of an ounce = $\left(\frac{1}{1{,}000{,}000} \text{ ounce}\right) = 1/16$ microgram or $\frac{1}{16{,}000{,}000}$ gram.

TABLE II

COMPARISON OF THE VITAMIN CONTENT OF THE MILLED FRACTIONS OF SEVERAL VARIETIES OF RICE[1]

VITAMIN	VARIETY	MILLED FRACTIONS MICRO-OUNCES PER POUND‡						
		Brown rice	1st Break	2nd Break	Brushed	Finished	Bran	Polish
Thiamine	Blue Rose	64.0	19.2	19.2	14.4	12.8	430.4	414.4
	Fortuna	70.4	25.6	14.4	8.0	9.6	425.6	456.0
	Early Prolific	67.2	36.8	22.4	16.0	19.2	481.6	249.6
	AVERAGE†	67.2	27.2	18.7	12.8	13.9	445.9	373.3
Niacin	Blue Rose	788.8	379.2	291.2	219.2	196.8	6,457.6	6,449.6
	Fortuna	750.4	326.4	272.0	148.8	153.6	7,798.4	6,876.8
	Early Prolific	728.0	531.2	478.4	224.0	257.6	5,356.8	5,139.2
	AVERAGE†	755.7	412.3	347.2	197.3	202.7	6,537.6	6,155.2
Pantothenic acid	Blue Rose	264.0	129.6	120.0	112.0	104.0	1,054.4	1,629.5
	Fortuna	297.6	137.6	123.2	97.6	100.8	1,300.8	1,769.6
	Early Prolific	254.4	168.0	128.0	153.6	104.0	1,068.8	1,152.0
	AVERAGE†	272.0	145.1	123.7	121.1	102.9	1,141.3	1,517.0
Pyridoxine	Blue Rose	150.4	68.8	41.6	41.6	32.0	380.8	473.2
	Fortuna	179.2	121.6	78.4	83.2	84.8	540.8	499.2
	Early Prolific	164.8	140.8	123.3	116.5	99.2	617.6	513.6
	AVERAGE†	164.8	110.4	81.1	80.4	72.0	513.1	495.3

TABLE II—Continued

VITAMIN	VARIETY	MILLED FRACTIONS						
		MICRO-OUNCES PER POUND‡						
		Brown rice	1st Break	2nd Break	Brushed	Finished	Bran	Polish
Riboflavin	Blue Rose	12.1	7.7	7.8	6.4	4.6	33.9	26.4
	Fortuna	8.3	7.3	4.7	4.1	3.6	29.3	30.7
	Early Prolific	9.0	5.5	3.2	2.9	3.2	39.7	28.3
	AVERAGE†	9.8	6.8	5.2	4.5	3.8	34.3	28.5
Biotin	Blue Rose	1.8	1.0	0.9	0.8	0.8	8.7	8.7
	Fortuna	2.0	0.9	0.8	0.8	0.5	7.8	13.3
	Early Prolific	2.0	1.2	0.9	0.7	0.7	6.0	9.5
	AVERAGE†	1.9	1.0	0.9	0.8	0.7	7.5	10.5
Inositol	Blue Rose	61,184.0	45,104.0	37,328.0	17,600.0	14,320.0	73,392.0	79,631.0
	Fortuna	65,840.0	47,936.0	36,240.0	27,824.0	20,224.0	65,805.4	75,600.0
	Ealy Prolific	50,224.0	35,328.0	22,704.0	22,364.0	18,208.0	46,576.0	51,472.0
	AVERAGE†	59,082.0	42,789.3	32,090.7	22,596.0	17,584.0	61,924.4	68,901.0

*All figures represent averages of a number of samples.

†Composite average.

‡Micro-ounces per pound = $\frac{1}{1,000,000}$ ounce per pound or one millionth of an ounce per pound = $^1/_{16}$ microgram per pound or $\frac{1}{16,000,000}$ per pound.

in the vitamin content of the several varieties was demonstrated. Some slight differences were apparent when individual values were compared with averages or when a simple rank number was assigned to each variety for the different vitamins and the ranking scores totaled. After such a procedure, the long-grain rice, such as Nira and Fortuna, were highest in vitamin content. The Rexoro, Blue Rose, and Early Prolific varieties occupied an intermediate position, and the shortest-grain variety of them all, American Pearl, was lowest. This finding seemed reasonable since, in general, the long-grain varieties have more surface per volume and hence more area of bran layers.

As is shown in Table II, without exception the vitamin content of the rice samples was found to decrease with increased milling, i.e., as the rice proceeded from the brown to the polished form. This conclusion agrees with data obtained for other grains and demonstrates that for rice, also, the members of the B complex are located principally in the bran coats and germ of the grain. Since approximately 50-70 per cent of the vitamins were removed in the first milling operation (from brown to first break rice) and the remaining three operations removed only an additional ten per cent, even an undermilled rice is not an outstanding source of B vitamins.

Rice polish and rice bran proved themselves excellent sources, and brown rice a good source, of all the vitamins studied except riboflavin. White cornmeal and hominy grits contained as much riboflavin per unit weight as did brown rice, even though the former products are not whole grain ones. Polished rice contained no important amounts of any of the B vitamins with the possible exception of pyridoxine and inositol. Since human requirements for these vitamins have not been established, however, their dietary value in rice cannot be judged. From Table II it may be seen that brown rice generally loses from 66-87 per cent of its vitamin content in the milling process, and polished rice contains only eight per cent of the vitamin content of rice polish.

The daily consumption of rice in southern Louisiana is approximately one-third to one-fourth pound per person, and on such a basis represents a sizeable portion of the daily food intake and furnishes the major part of the individual's carbohydrate requirement. Although this quantity is almost entirely polished rice, it supplies one-twenty-fifth of the person's thiamine need and one-seventeenth of his niacin requirement. The same amount of brown rice would supply one-quarter to one-fifth of an individual's thiamine and niacine requirement, and, therefore, it is obvious that diets containing such sizeable quantities of polished rice must be balanced with other foods which are rich in B vitamins. The potentialities of brown rice as a food cannot be overemphasized, not to mention those of rice polish and rice bran. Every opportunity to use these whole grain products should be taken. When the function of other B vitamins is fully understood, brown rice, rice polish, rice bran, and perhaps polished rice also may assume added importance as food sources of the B complex.

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INCREASING THE MARKET OUTLETS FOR LOUISIANA WINTER VEGETABLES THROUGH MIXED SHIPMENTS

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INCREASING THE MARKET OUTLETS FOR LOUISIANA WINTER VEGTABLES THROUGH MIXED SHIPMENTS

by

P. T. Ecton

Market reports issued by the United States Department of Agriculture show that 368 carloads and 175 truckloads containing more than one kind of winter vegetable were transported from Louisiana during 1943. The kinds of vegetables shipped in mixed carloads are not shown in the daily market reports. It is the purpose of this study to gather information on the volume of each vegetable transported in mixed lots and to analyze the importance of transporting Louisiana vegetables to market in mixed shipments in relation to available market outlets.

Mixed Shipments of Louisiana Winter Vegetables

This study reveals that these mixed shipments represent the equivalent of:

Shallots	71 carloads
Cabbage	140 carloads
Turnips	90 carloads
Collards	53 carloads
Parsley	40 carloads
Mustard	10 carloads
Escarole	26 carloads
Beets	23 carloads

In addition there were 16 other miscellaneous vegetables in varying quantities.

Method of Investigation

A record was made of all mixed shipments leaving the state. This was secured by listing the actual weights of vegetables in mixed cars as shown on the railroad waybills, through the cooperation of the initial carriers. The contents of the mixed truckloads were secured from the inspection certificates of these trucks through the cooperation of the State Supervisor of Inspection.

History of Mixed Shipments

Louisiana mixed shipments of the winter vegetables consist principally of shallots, cabbage, the root and leaf crops. The only other mixed shipments of any volume are composed of beans, peppers, cucumbers, and squash in May and June from Tangipahoa Parish. In 1920 about 1,000 cars were shipped with increasing shipments until a peak of 4,388 cars was reached in 1925. This soon fell back to shipments of around 2,000 carloads in 1929 and then about 1,000 cars in 1932, with a fluctuation below this ever since. Figure 1 illustrates these annual movements and compares them with Texas, Florida, and California, the principal competitors in the mixed car business.

Shipping Points

The shipping area borders the east and west banks of the Mississippi river from Baton Rouge to several miles below New Orleans as shown in Figure 2. The present shipping points are Donaldsonville, Gonzales, Plaquemines, White Castle, Raceland, Thibodaux, Convent, Belmont, Remy, St. James, Vacherie, La Place, Reserve, St. Rose, Kenner, and Violet. The most important in volume of mixed cars are Violet, La Place, Belmont, Convent, and Thibodaux. From 1920 to 1931 Destrehan, Good Hope, Hahnville, Killona, Luling, Garyville, Montegut, and Napoleonville were heavy shippers but declined about the time that Texas and California increased their volume of mixed shipments.

Number of Cars Shipped

It is difficult to compare the number of mixed cars with the number of straight cars of the same commodities since government carload records have never included shallots, a basic commodity of the

Table 1. — Number of Mixed and Straight Carloads of Vegetables Shipped from Louisiana from 1933 through 1943.

Year	*Mixed Cars*	*Straight Cars*
1933	539	[1]
1934	963	[1]
1935	444	[1]
1936	841	[1]
1937	750	[1]
1938	578	[1]
1939	645	[1]
1940	333	840
1941	540	1,070
1942	462	1,233
1943	368*	661

[1]—Data not available. *—Preliminary.

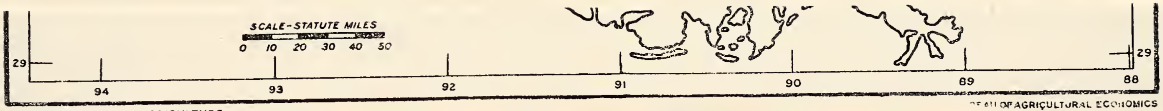

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Figure 2—Location of Winter Vegetable Growing Area of Louisiana.

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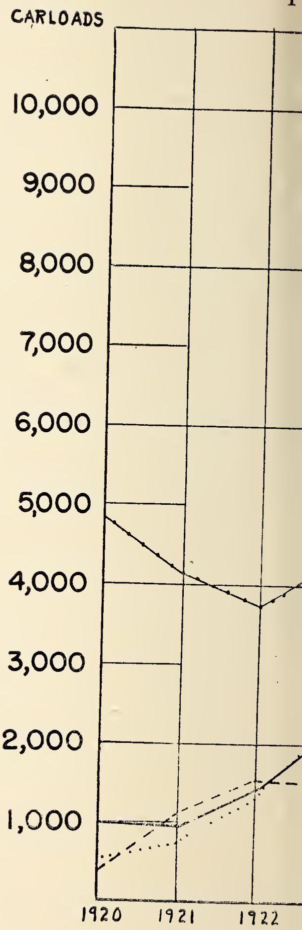

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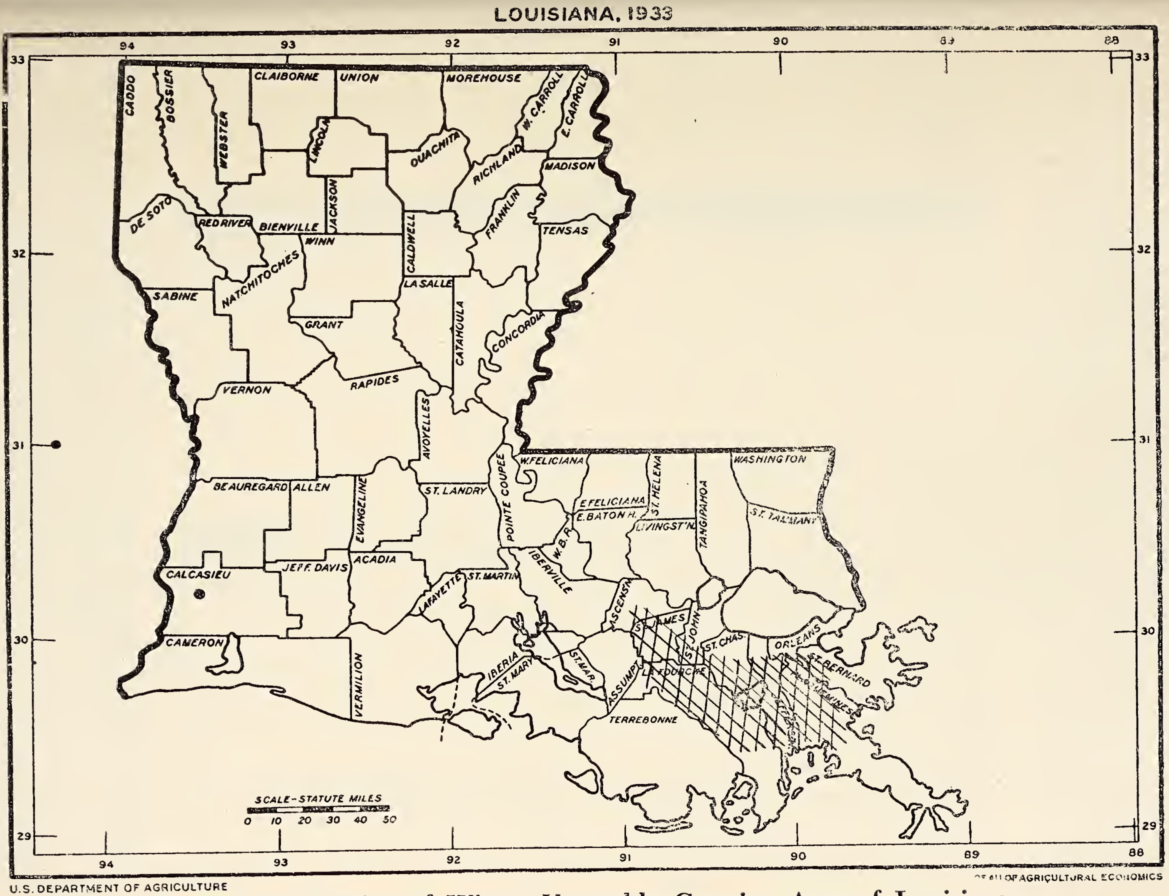
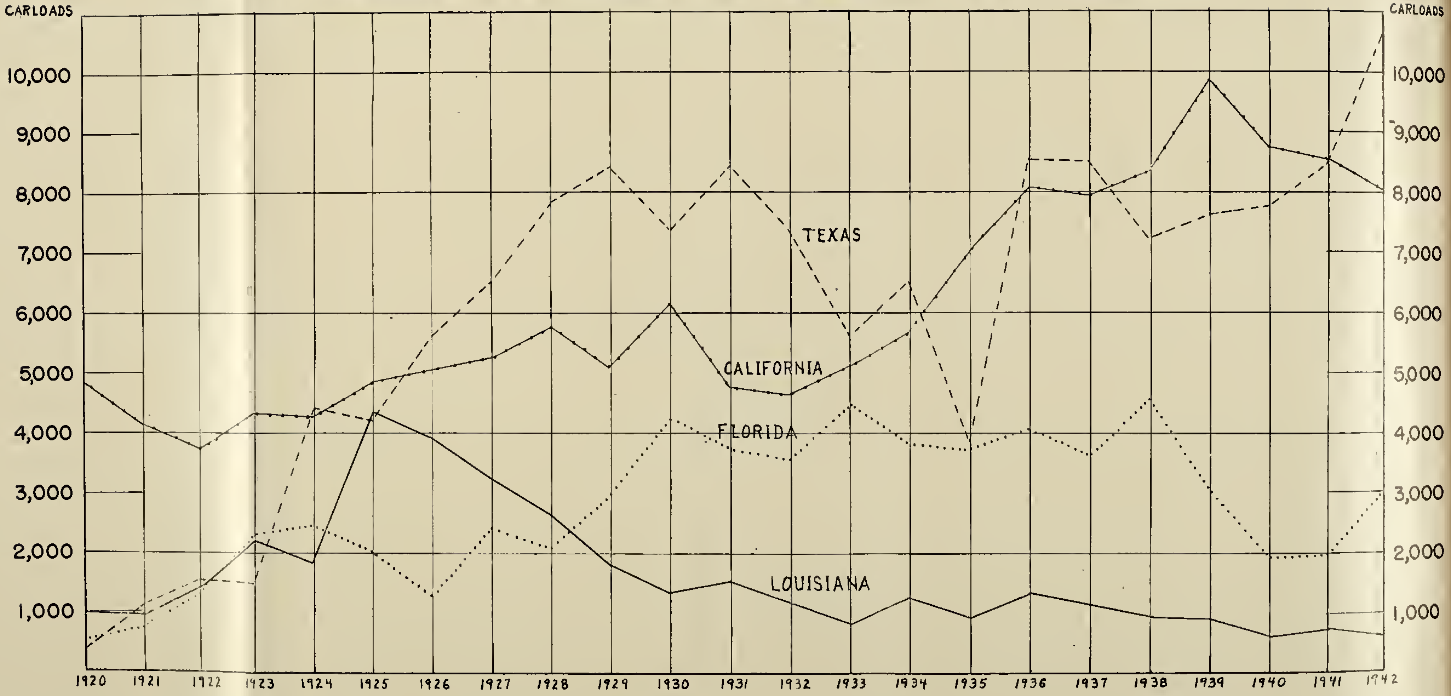


Figure 2—Location of Winter Vegetable Growing Area of Louisiana.

Figure I—Total Shipment of Mixed Vegetables From Louisiana, Florida, Texas and California, 1920-1942.



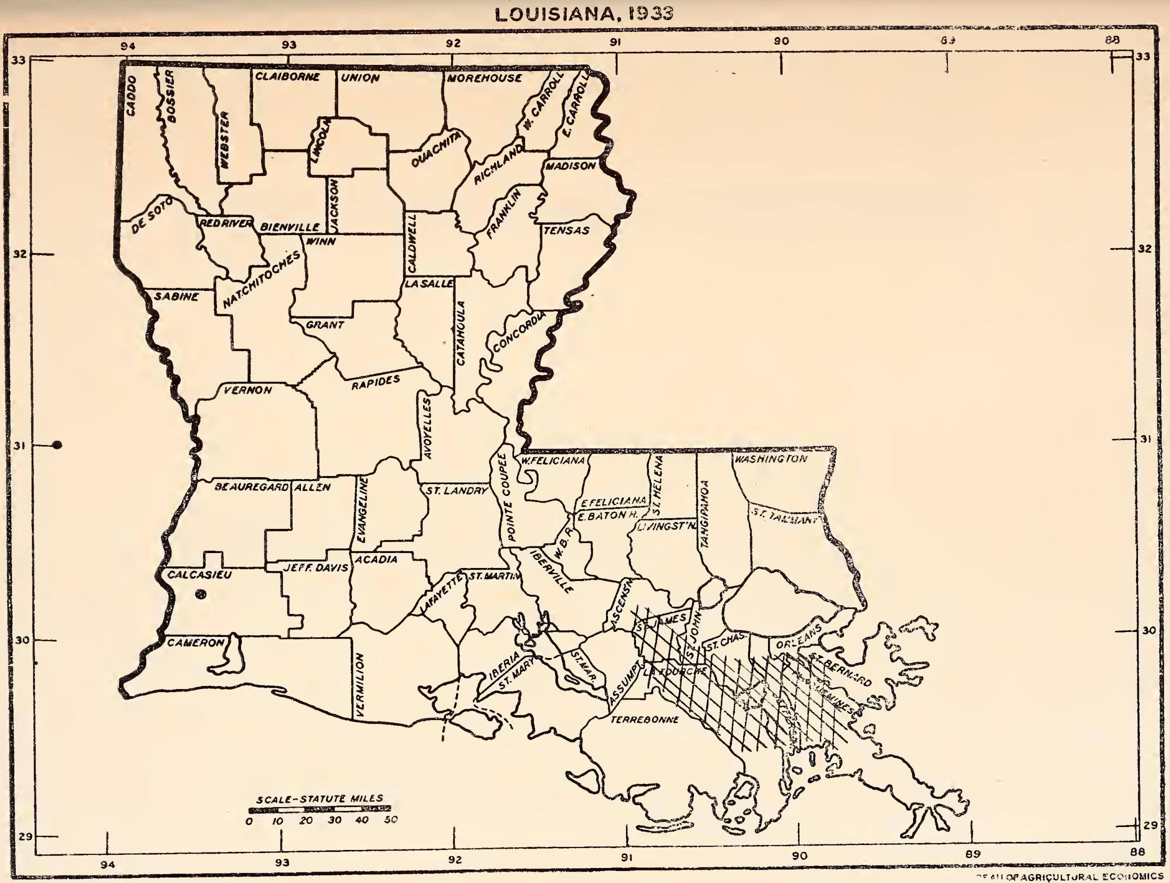


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Figure 2—Location of Winter Vegetable Growing Area of Louisiana.

mixed cars. These shallot records have been secured for 1940, 1941, 1942, and 1943 so a total of all straight carloads are included in Table 1 with the mixed cars from 1933 through 1943. The mixed cars in this table are those shipped from the shipping points mentioned in the previous paragraph. The vegetables included in the straight carloads are: shallots, cabbage, beets, turnips, and greens.

Contents of Mixed Carloads

The Market News Services report the shipment of all cars of perishables daily so that receivers and shippers may consider the supplies of each commodity available to the markets. When more than one commodity is loaded in a single car it is reported as a "mixed carload" with no indication of its contents. It may contain a half a car each of two commodities, or it may contain six or ten commodities, or it may be a solid car of one commodity with just a few crates of some other commodity included in the car as a sample to the receiver. In 1933 and 1934 and again in 1942 and 1943, the writer personally examined the waybills of 1,156 carloads of mixed vegetables to find the actual contents of these cars. The results from that examination are shown in Table 2.

TABLE 2. — PERCENTAGE OF CONTENTS OF MIXED CARLOADS

Commodity	1943	1942	1934	1933
	%	%	%	%
Shallots	16	53	34	41
Cabbage	30	27	21	28
Turnips	13	5	17	7
Collards	9	3	7	5
Parsley	11	—	2	—
Mustard	2	—	3	1
Escarole	7	—	2	3
Beets	5	5	3	3
Others	7	7	11	12
	100	100	100	100

Table 2 shows that the four principal commodities in mixed carloads are shallots, cabbage, turnips, and collards. It is not surprising to find that shallots and cabbage form the larger part of these cars since they are also important straight carload crops, but turnips and collards have not been considered important since they seldom appear in carload shipments. However, this study shows that the combined volume of the 1943 shipments will equal 48 cars of turnips and 33 cars of collards. Parsley, escarole, beets, and mustard are the other commodities which appear in quantites of more than 1 per cent of the carlot averages. The increase in volume of these commodities in recent years has been due to the development of the shipping area around Violet below New Orleans. This section now ships more mixed cars with a greater variety of vegetables than any of the other points. This partly accounts for the gradual decrease in the percentage of shallots, though the general demand for shallots has decreased and the demand for cabbage has increased. The contents of the mixed cars compared with the same commodities moving in straight cars in 1943 is illustrated in Figure 3. Mixed cars comprised about 30 per cent of the 1943 total movement and 27 per cent of the 1942 total movement. The ratio of the various vegetables varied with the shipping points. In the areas where only a few kinds of vegetables are grown, the percentages of shallots and cabbage are much higher as shown in Table 3.

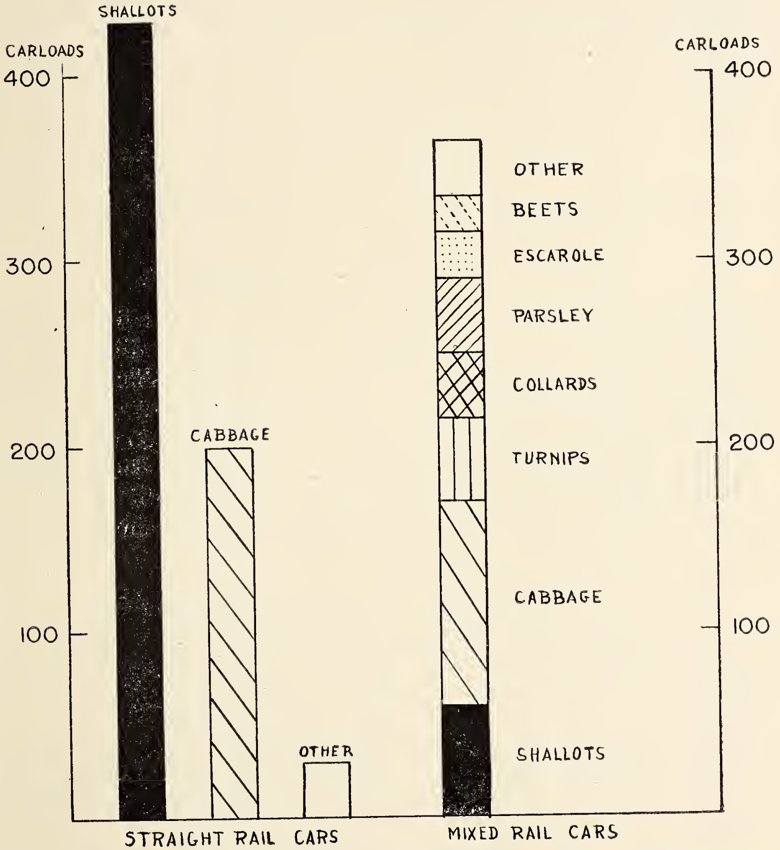

Figure 3—**Railroad Shipments of Straight and Mixed Carloads of Winter Vegetables in 1943 from Louisiana.**

Table 3. — Volume of Vegetables in Mixed Carloads from Principal Shipping Points in 1943

Kind of Vegetable	*La Place*	*Belmont and Remy*	*Violet*	*Convent*	*Thibodaux*
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Shallots	17	44	10	9	54
Cabbage	42	55	10	75	34
Turnips	12	—	16	10	12
Collords	7	—	12	1	—
Escarole	—	—	13	—	—
Endive	—	—	3	—	—
Parsley	—	—	22	—	—
Beets	9	—	5	—	—
Mustard	2	—	2	1	—
Others	11	1	7	4	—
	100	100	100	100	100

Number of Vegetables in Mixed Carloads

The mixed cars from Convent, Thibodaux, and the Belmont-Remy section usually contain mainly shallots and cabbage with occasionally turnips or collards. The cars from La Place and Violet contain a greater variety of vegetables, some cars having as many as nine kinds. St. Rose and Kenner usually ship many cars of vegetables, but are temporarily low in shipments because of the keen competition for labor from wartime industries in New Orleans. Table 4 shows the relative number of commodities from the principal shipping points.

Table 4. — Number of Kinds of Vegetables in Carloads from Principal Shipping Points in 1943

Number of vegetables in car	*Number of carloads shipped from*			
	La Place	*Violet*	*Belmont-Remy*	*Convent*
	Number	*Number*	*Number*	*Number*
Two	53	6	36	11
Three	31	9	3	1
Four	20	28	—	1
Five	11	60	—	1
Six	2	45	—	—
Seven	1	20	—	—
Eight	—	9	—	—
Nine	—	2	—	—

In addition to the principal vegetables listed in Table 2, several other vegetables are shipped in minor quantities. They are carrots, spinach, broccoli, kohl-rabi, fava beans, roumain, anise, garlic, leek, and celery. Later in the spring there are occasional packages of beans, squash, cucumbers, corn, peppers, and eggplants.

Mixed Truckload Shipments

Of the approximately 458 truckloads of winter vegetables moving from the state in 1943, 175 contained more than one kind of vegetable. The contents of these mixed truckloads were tabulated and investigated in the same way as for the rail shipments. It was found that the volume of shallots decreased, as compared with the rail shipments, and the volume of turnips and collards increased considerably as shown in Table 5.

TABLE 5. — CONTENTS OF MIXED TRUCKLOAD SHIPMENTS IN 1943

Commodity	*Per cent of total*
Shallots	8.4
Cabbage	29.6
Turnips	34.6
Collards	14.0
Beets	4.3
Mustard	2.0
Spinach	1.2
Bróccoli	3.4
Kale	.5
Escarole	.2
Carrots	.2
Others	1.6
	100.0

A comparison of these mixed trucks with straight truckloads of the same commodities is illustrated in Figure 4. The mixed truckloads were 38 per cent of the total truckload movement in 1943.

The number of commodities in these mixed truckloads is similar to the rail shipments, ranging from two to seven in number, but mostly containing two or three as shown in Table 6.

Relative Volume of Rail and Truck Shipments

The truck shipments of all winter vegetables, both straight and mixed, were 23 per cent of the total movement in 1943, and 14 per cent in 1942. The average truckload contained about 70 per cent as much produce as a railroad carload. The truck movement is increasing somewhat because of a growing demand in the southern markets for vegetables. The comparison of the truck movements, straight and mixed, with rail movements in 1942 and 1943 is shown in Figure 5.

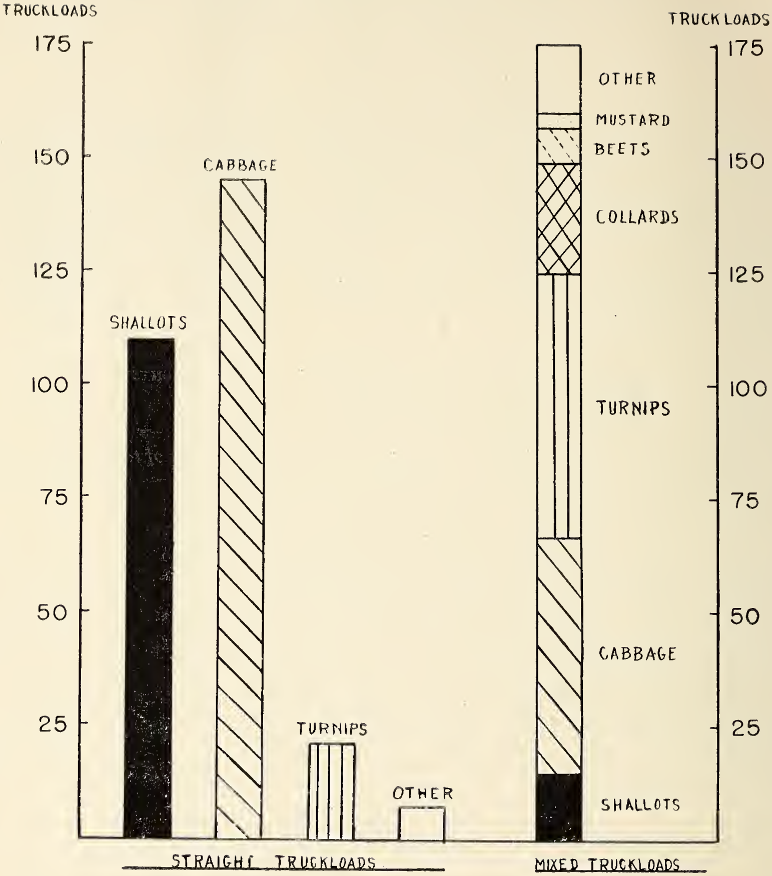

Figure 4—**Motor Truck Movement of Straight and Mixed Truckloads of Winter Vegetables in 1943 from Louisiana.**

TABLE 6. — NUMBER OF COMMODITIES IN MIXED TRUCKLOADS IN 1943

No. of commodities	*No. of truckloads*
Two	55
Three	68
Four	29
Five	17
Six	5
Seven	2
	175

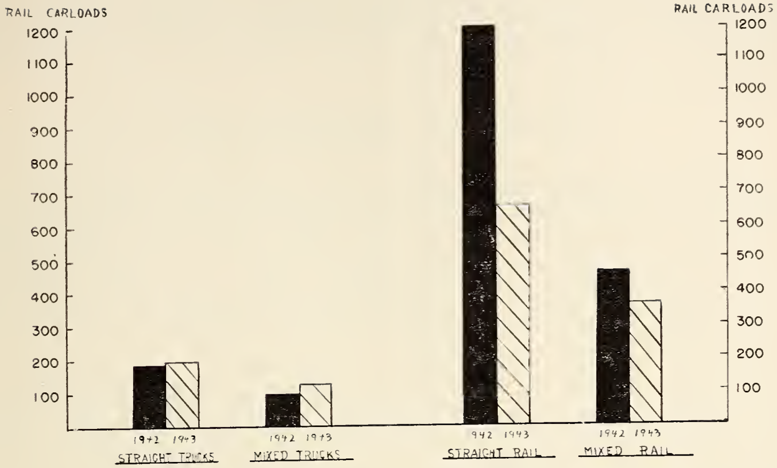

Figure 5—Comparative Movement of Louisiana Winter Vegetables in 1942 and 1943 by Truckload and Railroad Carload. Trucks are shown in rail car equivalent.

Time of Movement

Louisiana vegetable crops move principally during the six winter months starting in November. Weather may shorten or lengthen the season by a month on either end. During the 1943 season the movement from the principal points averaged as follows:

January	19 per cent
February	13 per cent
March	15 per cent
April	22 per cent
May	12 per cent
November	9 per cent
December	10 per cent

Destinations of Mixed Shipments

It is difficult to determine final destinations of mixed cars since many are billed for later diversion, and some are billed to terminals for inspection and later are re-consigned. However, it is evident that the majority moved into the principal terminals. Of the 1943 cars, 42 per cent were billed to Chicago, 12 per cent to Cleveland, 10 per cent to New York City, 9 per cent to Cincinnati, 8 per cent to Detroit, 4 per cent to Toronto, and smaller percentages to St. Louis, Buffalo, Pittsburg, Philadelphia, Montreal, and to Fulton, Kentucky for diversion. Among the smaller cities and towns served are Decatur, Illinois; Green

Bay, Wisconsin; Logansport, Indiana; Grand Rapids, Michigan; Lexington, Kentucky; Albany, New York; Lafayette, Indiana; Daton, Illinois; La Salle, Illinois; Burlington, Iowa; Racine, Wisconsin; Syracuse, New York; and Nashville, Tennessee.

Disadvantages of Mixed Shipments

1. The principal disadvantage of mixed car shipments is the necessity of receiving the order first and agreeing on the number of containers of each commodity to be loaded in the car. This puts the mixed car in a poor competitive position with the straight car which may be loaded to the standard minimum when the crop is ready and selling may proceed while the car is being loaded or even after it is enroute to the northern markets.

2. The cost of the vegetables loaded in smaller quantites in a mixed car is sometimes higher than their cost from competing sections where they are grown in larger volume and can be shipped in carlots. Assembling costs run higher on a mixed car.

3. The movement of mixed cars confuses market information, as the contents of the car is not reported by the crop reporting service, and supplies on the terminal cannot be calculated.

4. All of the vegetables in a mixed shipment cannot be harvested at the peak of their quality.

5. In case of the rejection of a mixed car its diversion and resale is more difficult than a straight carload.

Advantages of Mixed Shipments

1. The principal advantage of mixed cars is that they may be shipped direct to smaller towns which could not handle a straight car of any of the vegetables included in the mixed cars. This has become especially important in the present war since motor trucks are limited for redistribution of straight cars from terminal cities to smaller cities. This is borne out by the fact that mixed shipments were 30 per cent of the winter vegetable movement in 1943 compared with 27 per cent in 1942.

2. Vegetables can be delivered to consumers in smaller cities more cheaply in mixed cars since cartage and rehandling in the terminal is saved. Also the saving of one to three days in delivery means fresher vegetables and the avoidance of from 2 to 10 per cent in spoilage and the resultant increased price which must be obtained for the unspoiled portion in order to cover costs.

3. The mixed car is advantageous in the terminal markets since it may be handled more quickly by smaller brokers with quicker reorders and resultant fresher supplies.

4. New vegetables may be introduced via mixed cars in small

lots for the purpose of creating a demand for them in larger quantities. Sample crates of vegetables approaching harvest may be included for inspection.

5. Mixed shipments may be used at the beginning and end of harvest seasons to secure carlot volume.

6. Mixed cars may be sold direct to jobbers in the terminal markets thereby going around the carlot receiver and saving one handling expense.

7. The risk of declining prices is distributed in a mixed car as the market is not so likely to break on all of the vegetables at one time.

8. "At times when supplies are relatively scarce and attendant prices high, the need for mixed cars is most pronounced. Obviously, damage and waste eliminated at this time is especially important owing to the value of the merchandise. When supplies are plentiful, sufficient to saturate the nation's markets, its is possible to move full cars of most items into all markets except some of the smallest ones; consequently loading of mixed cars at these times falls off. It is apparent, therefore, that the kind of commodity, its scarcity or plentifulness, a strong or limited demand, are important factors in determining whether cars should be loaded straight or mixed," says a national authority.

Louisiana's Competitive Situation

Since 1925 Louisiana has fallen from a strong second to a low fourth in the shipment of mixed vegetables. The more important states are Texas, California and Florida. There are several reasons for this. Investigations show these other states have a greater variety of vegetables in their mixed cars, although we are producing most of the vegetables in fair quantity except brussel sprouts, cauliflower, artichokes, spinach, and carrots. The principal difference seems to be that while Louisiana's basic mixed vegetabales are cabbage, shallots, turnips, and collards, the other states build their mixed shipments around cabbage, carrots, and beets with lesser amounts of broccoli, cauliflower, peas, spinach, and the other speciality vegetables. The United States average shipments of winter vegetables in straight carlots are: cabbage, 42 per cent; carrots, 39 per cent; broccoli, 3 per cent; beets, 2 per cent; greens and escarole, 4 per cent; and turnips, 1 per cent. The competing states are following these general consumption demands. However, Louisiana mixed cars contain few carrots and have only recently increased the shipment of beets.

Louisiana's decrease in vegetable movement and Texas and California's increase date from 1924 and 1925, when carrots, especially, and beets began to increase in acreage. These states could produce a better colored carrot on the lighter soils where moisture could be controlled by irrigation. Excessive rains on the heavy soils of Louisiana cause carrots to bleach to a lemon color which throws them off grade.

Dr. J. C. Miller is developing a carrot which will have the proper color in Louisiana soils. This seems to be a necessary development before Louisiana can regain its former volume in mixed cars, providing all quality can be brought up to a par with competing states. Many dealers who were attracted to the new vegetable sections became producers and developed their own growing sections. Naturally they are interested in selling their own merchandise first which puts Louisiana growers and shippers at a disadvantage in the markets.

Importance of Minor Crops

Many of the vegetables in mixed shipments never appear in government statistics and have not been considered very important to the farmers of Louisiana as a source of revenue. However, a study of the volume of unreported minor crops transported by means of truck and rail shipments and the volume sold in the farmer's section of the French Market in New Orleans indicates that they are important. In 1943, the volume of unreported crops marketed through the three channels were as follows:

Turnips	4,957,654 pounds	206 cars
Collards	1,570,321 pounds	89 cars
Parsley	1,408,803 pounds	80 cars
Mustard	939,002 pounds	54 cars
Escarole	618,036 pounds	35 cars
Broccoli	308,863 pounds	15 cars
Kohl-Rabi	50,878 pounds	2 cars
Kale	21,089 pounds	1 cars
Okra*	1,245,280 pounds	71 cars
		553

All French Market*

Summary

1. The principal vegetables in Louisiana mixed cars in order of importance are cabbage, shallots, turnips, and collards. These products constitute about 30 per cent of the total carload movements. Shallots have been decreasing and cabbage increasing in relative volume marketed.

2. Louisiana is growing a considerable volume of vegetables which are moving in mixed shipments that have been considered of minor importance. These crops are turnips, collards, parsley, mustard, escarole, and beets.

3. The recent development of the section around Violet has increased the number of commodities in the mixed car. This section averages five vegetables to a car while the other sections average from two to three.

4. Mixed truckloads consist principally of turnips, cabbage, collards, and shallots in that order. The mixed truckloads were 38 per cent of the total truckload movement in 1943.

5. The transportation of vegetables to market in mixed lots has more advantages than disadvantages. It is the cheapest method of supplying fresher vegetables to small villages and towns. The wartime shortage of trucks for redistribution of vegetables from the terminal markets has added importance to the mixed carloads, since it can move directly to the final destination saving expense and loss from deterioration.

6. Louisiana lost a big share of the mixed car business to Texas, California, and Florida about 1924 and 1925, when these states took away the carrot business, a basic item of the mixed car.

7. Dealers anticipate an increase in the demand for cars and trucks loaded with more than one kind of vegetable.

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Experiments With Cotton, Corn, Sorghum, and Soybeans at the Rice Experiment Station, Crowley, Louisiana

By

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Experiments With Cotton, Corn, Sorghum, and Soybeans at the Rice Experiment Station, Crowley, Louisiana[1]

J. MITCHELL JENKINS[2]

INTRODUCTION

While rice is the principal crop grown in southwestern Louisiana, other crops, especially cotton, corn, and soybeans, are grown extensively on similar lands in the northeastern portion of the prairie regions, and to some extent throughout the area where rice is grown. Frequent requests for information on these minor crops prompted the Louisiana Agricultural Experiment Station to conduct experiments with them at the Rice Experiment Station, Crowley, La.

The purpose of this publication is to present the pertinent experimental data obtained on cotton, corn, sorghum, and soybeans in the 15-year period from 1928 to 1942, inclusive.[3] These tests have all been completed.

The land devoted to this work was acquired several years after the Station was established. The soil is Crowley silty loam and is typical of a large portion of the land in the rice area, and for 25 years or more had been devoted to commercial rice culture. The general practice in rice farming is to grow a rice crop every other year and use the land in the intervening years for pasture. Up to the time this land was acquired by the Station, good crops of rice were produced on it without the use of commercial fertilizers.

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[1] Cooperative investigations between the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, and the Louisiana Agricultural Experiment Station.

[2] Associate Agronomist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, and Superintendent of the Rice Experiment Station, Crowley, Louisiana.

[3] The experiments were planned by and conducted under the general superivision of H. B. Brown, F. L. Davis, John P. Gray, and J. R. Cotton, Agronomist, Associate Soil Technologist and Associate Agronomists, respectively, of the Louisiana Agricultural Experiment Station. The author is indebted to Mr. John H. Martin, Senior Agronomist, in charge of Sorghums and Broomcorn Investigations, Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, for furnishing much of the sorghum seed and for helpful suggestions.

TABLE I—Annual and average yields for 20 cotton varieties grown at the Rice Experiment Station, Crowley, Louisiana, 1928 to 1942, inclusive*

Variety	Yield of Lint Cotton in Pounds per Acre												Average				
	1928	1929	1930	1933	1934	1935	1936	1937	1938	1939	1941	1942	5 yrs. 1928-34	3 yrs. 1930-34	4 yrs. 1934-37	3 yrs. 1936-38	4 yrs. 1938-42
Half & Half	158	230	462	281	216	535	344	393	589				269	320	372	442	
D. & P. L. No. 4-8	175	245	357	277	234								258	289			
Stoneville-2	179	224	286	334	239	452							252	293			
Wilson Cleveland	175	243	359	279	197								251	278			
Express-317	124	218	338	265	175								224	259			
Rowden-40		179	261	290	198	411								250			
Missdel No. 2		181	281	306	200									262			
D. & P. L. No. 10			350	366	265	504	403	465						327	417		
Delfos 2323			274	314	248	422								279			
Lankart				241	150	357	359	309	484						294	385	
Deltapine				323	211	495	415	446	601	464	416				392	488	
Stoneville-3				369	287	473	442	422							406		
Station Miller				252	136	441	371	395	713	501	515	394			336	493	531
Delfos 978					240	455	341	330	545						342	405	
Missdel-3					176	356	277	277							272		
Delfos 531A						428	363	349	473	334	328					395	
Stoneville 2B							465	448	383	459	418	359				432	405
Stoneville-5							440	492	696	451						543	
Delfos 130							334	324	520		399					393	
Dixie-Triumph 366									734	495	530	435					549

* None grown in 1931; yields not recorded in 1932; crop destroyed by flood water in 1940.

EXPERIMENTAL RESULTS

Cotton Varieties

In the 15-year period from 1928 to 1942, approximately 100 cotton varieties and strains were grown in plots replicated 5 times. The varieties were grown on the same land each year, and received an annual application of about 500 pounds per acre of a complete fertilizer. Some varieties were discarded and others added to the test from year to year, so the results are not comparable except for a relatively few varieties that were grown for periods of 3 to 5 years. The varieties were not grown in 1931, yields were not recorded in 1932, and the crop was destroyed by floods in 1940.

The estimated yield of lint cotton in pounds per acre for twenty varieties in given in Table 1.

In the period from 1928 to 1934, five varieties were grown continuously and the highest average yield of lint cotton was from Half & Half, and the lowest for Express-317. In the three years 1930-1934, four additional varieties were included in the test, and the highest average yield of lint cotton during this period was for D. & P. L.-10. Half & Half and Stoneville-2 ranked second and third, and Rowden-40 was lowest in yield.

In the 4-year period (1934-37), the three highest yielding among seven varieties were D. & P. L.-10, Stoneville-3, and Half & Half in the order listed.

In the 3-year period (1936-38), the three highest yielding varieties among eight were Stoneville-5, Station Miller, and Deltapine in the order given.

In the 4-year period (1938-42), Dixie-Triumph 366 was highest in yield, with Station Miller a close second.

Of the varieties tested in the later years, Dixie-Triumph 366, Stoneville-5, Stoneville 2B, and Station Miller gave the highest average yields. These varieties, and also Deltapine appear to be well adapted for growing in the rice area.

FERTILIZERS FOR COTTON

Various Formulas

A fertilizer experiment using varying quantities of nitrogen, phosphorous and potash was conducted for a period of 10 years in quadruplicate 2-row plots, on the same land. The results for this experiment are recorded in Table 2. The highest 10-year average yields of seed cotton were from the application of the 5-16-4, 5-8-8, and 7-8-4 formulas, respectively. The lowest average yields were from applications of the 5-0-4, 5-8-0, and 0-8-4 formulas, in the order given.

TABLE 2—ANNUAL AND 10-YEAR AVERAGE YIELDS FOR COTTON-FERTILIZER EXPERIMENT AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, 1928-1938, INCLUSIVE[1]

FERTILIZER[2] APPLIED AT RATE OF 600 POUNDS PER ACRE	Yield of Seed Cotton in Pounds per Acre											AVERAGE ANNUAL INCREASE OVER CHECK
	1928	1929	1930	1932	1933	1934	1935	1936	1937	1938	10-yr. average	
5-0-4	536	271	462	286	559	501	941	788	477	488	531	165
5-4-4	545	633	924	458	964	768	1509	1212	1116	1314	934	568
5-8-4	547	778	885	458	875	809	1577	1311	1347	1465	1005	639
5-12-4	544	775	982	437	791	869	1604	1371	1464	1480	1032	666
5-16-4	670	859	966	458	809	864	1592	1370	1550	1631	1077	711
0-0-0	423	255	371	122	367	385	699	482	364	360	383	—
0-8-4	585	633	837	236	414	511	1122	906	989	1123	736	370
3-8-4	655	771	856	376	621	679	1363	1149	1205	1358	903	537
4-8-4	722	785	875	394	737	750	1426	1180	1232	1340	944	578
5-8-4	770	798	933	541	813	837	1551	1227	1275	1450	1020	654
6-8-4	778	746	875	516	922	889	1543	1177	1240	1347	1003	637
7-8-4	747	827	924	567	1002	946	1619	1297	1303	1292	1052	686
0-0-0	538	246	313	136	403	302	569	445	249	286	349	—
5-8-0	596	575	394	426	795	638	1057	744	706	1007	694	328
5-8-2	769	672	733	455	817	767	1380	1082	1134	1260	907	541
5-8-4	783	795	846	508	875	883	1431	1231	1263	1479	1009	643
5-8-6	839	778	950	505	820	745	1602	1316	1186	1436	1018	652
5-8-8	878	795	985	469	802	780	1677	1413	1362	1525	1069	703

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[1] No test was conducted in 1931.

[2] In all cases nitrate of soda was used as the source of nitrogen, superphosphate as the source of phosphoric acid, and muriate of potash as the source of potash.

TABLE 3—ANNUAL AND 9-YEAR AVERAGE YIELDS FOR COTTON-FERTILIZER (POTASH REQUIREMENT) EXPERIMENT AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, FOR THE YEARS 1931-1939, INCLUSIVE

Analysis of Fertilizer[1] Applied at the Rate of 600 Lbs. per Acre	Yield of Seed Cotton in Pounds Per Acre									Average	Average Increase from	
	1931	1932	1933	1934	1935	1936	1937	1938	1939		Fertilizer	Potash
0-0-0	965	350	50	245	419	376	80	138	373	333	——	——
5-12-0	1435	465	565	523	1010	448	417	574	445	654	321	——
5-12-4	1600	655	840	664	1441	1177	927	1220	1131	1073	740	419
5-12-6	1750	605	840	664	1425	1252	1131	1341	1335	1149	816	495
5-12-8	1690	545	910	665	1592	1291	1180	1355	1352	1176	843	522
5-12-8[2]	1600	685	855	553	1385	1145	1159	1368	1203	1106	773	452
5-12-12	——	——	880	549	1525	1045	1127	1126	1178	1061[3]	728[3]	407[3]

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[1] Superphosphate was used as the source of phosphoric acid and muriate of potash as the source of potash throughout the experiment. Nitrogen was supplied by nitrate of soda in 1931 and by sulfate of ammonia in the other years.

[2] The potash was applied as a side-dressing (100 pounds of muriate of potash per acre) after chopping out.

[3] 7-year average.

Potash Requirements for Cotton

An experiment was started in 1931, and conducted in quadruplicate 4-row plots over a period of 9 years, to determine the potash requirements for cotton. The yields were determined from the two inside rows of each plot. The results are shown in Table 3. The 9-year average (1931-1939) yields indicate that the application of 48 pounds of potash per acre before seeding, in a 5-12-8 mixture, is sufficient to produce maximum yields of seed cotton. Potash used as a side dressing was less profitable than when applied before seeding.

Sources of Phosphorous for Cotton

An experiment to determine the best source of phosphorous for cotton was conducted on the same land in 4-row quadruplicate plots for a 7-year period (1933-1939). The results are recorded in Table 4. The two inside rows were used in estimating yields. The highest average increase in the yields of seed cotton was from plots that received bone meal as a source of phosphorous. However, the average yields from the plots that received basic slag, citratus, and superphosphate were only slightly lower. The results indicate, therefore, that each of these sources of phosphorous is satisfactory for cotton.

Rates of Applying Fertilizers to Cotton

An experiment was started in 1939 and continued through 1942 for the purpose of obtaining information regarding the most profitable fertilizer and rate of application for cotton. Two formulas, 3-10-3 and 6-8-6, were used and each was applied at the rate of 150, 300, 450, and 600 pounds per acre, respectively. The experiment was conducted on the same land each year in 4-row quadruplicate plots. The two inside rows of each plot were used in estimating yields. The results are shown in Table 5. The highest 3-year average yield was from the 3-10-3 formula applied at the rate of 450 pounds per acre, and the average yields from the 6-8-6 formula applied at the rate of 600 and 450 pounds ranked second and third, respectively.

TABLE 4—Annual and 7-year average yields for Cotton-Fertilizer (Source of Phosphorous) Experiment at the Rice Experiment Station, Crowley, Louisiana, for the years 1933-1939, inclusive.

Source of Phosphorous	Analysis of Fertilizer Applied at Rate of 600 Lbs. per Acre	Yield of Seed Cotton in Pounds per Acre							Average	Average Increase from Phosphorus
		1933	1934	1935	1936	1937	1938	1939		
No fertilizer-check	0-0-0	85	186	412	252	38	132	354	208	——
No phosphate-check	4-0-8	120	173	425	259	35	58	200	181	——
Superphosphate-alone	0-12-0	705	346	754	770	683	1010	602	696	515
Superphosphate	4-12-8	940	570	1517	1384	1294	1386	1434	1218	1037
Citratus	4-12-8	899	546	1448	1379	1217	1730	1475	1242	1061
No fertilizer-check	0-0-0	65	165	381	258	56	117	377	203	——
Ruhm's Phosphate	4-12-8	465	511	1523	1176	1087	1091	1304	1022	841
Rock phosphate	4-12-8	405	519	1269	1180	1023	1073	1309	968	787
Basic slag	4-12-8 [1]	915	755	1516	1322	1528	1689	1274	1286	1105
Bone Meal	4-12-8	890	643	1555	1365	1467	1659	1506	1298	1117

[1] Nitrate of soda was used to supply nitrogen on plot 9; sulfate of ammonia was used on all other plots. Muriate of potash was used to supply potash in all cases.

TABLE 5—ANNUAL AND 3-YEAR AVERAGE YIELDS FOR COTTON FERTILIZER (RATE OF APPLICATION) EXPERIMENT AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, FOR THE YEARS 1939, 1941 AND 1942.[1]

Formula	Amount per Acre Pounds	Yield of Seed Cotton per Acre			3-year Average Yield of Seed Cotton Lbs. per Acre	Increase over Check
		1939	1941	1942		
0-0-0 (Check)	——	1248	851	795	965	——
3-10-3	150	1351	1017	1004	1124	159
6-8-6	150	1407	923	1064	1131	166
3-10-3	300	1420	1003	1152	1192	227
6-8-6	300	1402	962	1256	1207	242
3-10-3	450	1553	1069	1220	1281	316
6-8-6	450	1525	985	1198	1236	271
3-10-3	600	1409	1062	1181	1217	252
6-8-6	600	1496	977	1308	1260	295

[1] Crop destroyed by flood in 1940.

Corn Varieties

Some twenty varieties of corn were grown in quadruplicate single-row plots, from 1932 to 1936, inclusive, in a 2-year rotation with soybeans, but the crop was a failure in 1932 and 1934. Soybeans were not grown in the corn as is commonly done in this area. Each year the corn and soybean plots each received approximately 400 pounds per acre of a 5-15-5 fertilizer. The estimated yield for 12 varieties grown during 5 years is given in Table 6.

TABLE 6—ANNUAL AND FIVE-YEAR AVERAGE YIELDS FOR 12 CORN VARIETIES GROWN AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, 1932 TO 1936, INCLUSIVE.

Variety	Grain Yields per Acre in Bushels					
	1932	1933	1934	1935	1936	Average
Yellow Creole	0	8.4	0	13.4	8.6	6.1
Cock's Prolific	0	9.9	0	10.5	11.4	6.4
Hastings Prolific	0	10.1	0	13.2	12.0	7.1
Whatley's Prolific	0	8.0	0	—	—	2.7 [1]
Mosby	0	—	0	8.8	—	2.9 [1]
Calhoun Red Cob	0	7.9	0	8.2	7.8	4.8
Iowa Silver Mine	0	3.0	0	12.1	9.0	4.8
Surecropper	0	19.4	0	16.4	14.0	10.0
Hill's Yellow Dent	0	8.3	0	10.7	12.6	6.3
Imperial White	0	6.6	0	13.9	7.9	5.7
Tuxpan	—	9.7	0	15.5	11.6	9.2 [2]
Sentell's White Dent	—	—	0	8.0	7.5	5.2 [1]

[1] Three-year average.
[2] Four-year average.

In most of the rice area in southwestern Louisiana, the limiting factor in growing corn is the sugarcane stalk borer. In the years 1932 and 1934, this insect destroyed the young plants; whereas, in other years the attack in large numbers did not occur until the plants were fruiting, and if the infestation was not too severe, some corn was produced.

The highest 5-year average yields were for Surecropper 10.0 bushels, Hastings Prolific 7.1 bushels, and Cock's Prolific 6.4 bushels per acre. The low yields are due largely to insect damage and other environmental conditions that are not particularly favorable for the growth of corn.

Date-of-Seeding Experiment With Corn

A date-of-seeding experiment with corn was conducted over a period of 6 years (1933-38) for the purpose of obtaining information relative to the best time to plant corn. The corn was planted on March 1 and at 2-week intervals thereafter until July 1. The test was conducted on the same land each year in 5-row quadruplicate plots. Biloxi soybeans were sown with the corn at the time of planting, but were not harvested. In addition to turning under the beans and cornstalks in the fall, each year the plots received approximately 500 pounds per acre of a complete fertilizer. The data for this experiment are recorded in Table 7.

TABLE 7—ANNUAL AND 6-YEAR AVERAGE YIELDS OF CORN GROWN IN DATE-OF-SEEDING EXPERIMENT AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, 1933-1938, INCLUSIVE

Dates Seeded	Yield per Acre in Bushels						
	1933	1934	1935	1936	1937	1938	Average
March 1	[1]	0.00 [2]	0.00 [2]	7.29	5.43	11.00	4.74 [3]
March 15	[1]	0.00 [2]	1.69	9.50	4.78	10.29	5.25 [3]
April 1	11.92	0.00 [2]	6.36	7.50	9.29	16.57	8.61
April 15	12.35	10.60	7.63	8.07	18.36	23.36	13.40
May 1	9.00	6.00	5.33	9.07	13.36	11.86	9.10
May 15	8.50	7.40	5.13	7.00	8.43	4.00	6.74
June 1	4.06	9.40	1.34	3.71	7.93	1.07	4.59
June 15	3.43	7.10	1.41	1.08	6.64	0.64	3.38
July 1	3.43	5.10	.37	1.28	3.64	0.00	2.30

NOTE: [1] Not seeded.

[2] Plants practically destroyed by sugarcane stalk borer.

[3] Five-year average.

The highest 6-year average yield was 13.4 bushels from planting on April 15, and the May 1 and April 1 plantings ranked second and third in yield, respectively. The main cause for the low corn yields was damage due to the sugarcane stalk borer. In some years, the young plants in the March and early April plantings were practically destroyed by the borer, and regardless of the date planted, the stalk infestation was always heavy. The results indicate, however, that borer damage was greatly reduced by planting about April 15.

Cotton and Corn Rotation

A rotation experiment consisting of cotton 2 years, and corn and soybeans 1 year, was conducted for a period of 8 years (1932-1939). The soybeans were planted with the corn, but not harvested. In the fall, after harvest, all corn, cotton, and soybean refuse was turned under. As a check, cotton was grown continuously in one series of plots. The experiment was conducted in quadruplicate plots, each consisting of ten rows spaced 4½ feet apart. Each year all plots, including the check, received an application of approximately 500 pounds per acre of 5-15-5 fertilizer. The results are given in Table 8.

The 4-year average yield of seed cotton from plots grown in rotation with corn and soybeans was slightly less than that of the check plots. The failure of the rotation to increase the yield of seed cotton and the low average production of corn clearly indicate that a rotation of this kind, under local conditions, would not be profitable.

TABLE 8—Annual and 8-year average yields of Cotton and Corn for Cotton and Corn Rotation Experiment at the Rice Experiment Station, Crowley, Louisiana, 1932 to 1939, inclusive.

Crop and Treatment [1]	Yield per Acre, Seed Cotton in Pounds; Corn in Bushels								
	1932	1933	1934	1935	1936	1937	1938	1939	Average
Check, Cotton, eight consecutive years	326	862	453	1074	1194	1123	1356	1233	953
Cotton, average of plots rotated with corn and soybeans	399	892	486	1279	1260	1137	932	1200	948
Corn	3.5	8.2	0.0 [2]	8.4	11.6	19.8	20.9	23.9	12.0

[1] All plots, each year, received 480 pounds of 5-15-5 fertilizer per acre.

[2] Corn destroyed by sugarcane stalk borer when still quite young.

Different Width Rows for Cotton and Corn

In the 5-year period from 1934 to 1938, corn and cotton were grown in rows spaced 4, 5, and 6 feet apart. The experiment was conducted on the same land each year in triplicate plots. No fertilizer was used. Barchet soybeans were seeded in the corn at the time of the last cultivation, but not harvested. The agronomic data for this experiment are recorded in Table 9.

The highest 5-year average yield of seed cotton was from plots in which the rows were spaced 4 feet apart, and the yield from the 5-foot spacing ranked second. The highest 5-year average yield of corn was from plots in which the rows were spaced 4 feet apart, and the yield from the 6-foot spacings ranked second.

TABLE 9—Annual and 5-year average yields of Corn and Cotton grown in 4, 5, and 6 foot rows at the Experiment Station, Crowley, Louisiana, for the years 1934 to 1938, inclusive.

Crops and Treatment [1]	Yield per Acre, Seed Cotton in Pounds; Corn in Bushels					
	1934 [2]	1935	1936	1937	1938	Average
Cotton:						
4 foot rows	616	899	828	603	551	699
5 foot rows	519	816	675	387	287	537
6 foot rows	422	843	610	381	319	515
Corn:						
4 foot rows	0.0	4.5	16.4	17.8	11.4	10.0
5 foot rows	0.0	3.3	13.1	16.0	10.3	8.5
6 foot rows	0.0	4.1	14.7	16.7	11.4	9.4

[1] No fertilizer was applied. Crops grown on same areas five consecutive years.

[2] Corn was destroyed by sugarcane borer.

Sorghums

In the 7-year period (1933-1939), about twenty varieties of grain sorghums and sorgo were grown in 4-row plots. They were included in a 2-year rotation with soybeans, and each year approximately 500 pounds per acre of a complete fertilizer was applied to the land. The varieties were seeded each year on two or three dates. The two inside rows of each plot were used in estimating yields. The yields of green forage and grain for the first cutting, for the earliest seedings, are given in Tables 10 and 11.

TABLE 10—ANNUAL AND 7-YEAR AVERAGE YIELDS OF GREEN FORAGE FOR GRAIN SORGHUM AND SORGO SEEDED ON TWO DATES AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, FOR THE YEARS 1933-1939, INCLUSIVE.

Variety	Yields of Green Forage per Acre, in Tons, from First Cutting														Average		
	1933		1934		1935		1936		1937		1938		1939				
	Seeded		Seeded		Seeded		Seeded		Seeded		Seeded		Seeded				
	April 22	May 15	May 19	June 20	May 17	June 24	May 1	May 23	June 8	July 1	May 12	July 14	May 8	June 26	First Seeding	Second Seeding	First & Second Seedings
Grain Sorghum:																	
Hegari	13.43	7.08	12.25	8.98	12.34	10.07	9.89	5.99	9.62	8.98	5.90	9.44	11.98	9.89	10.77	8.63	9.70
Chiltex	7.80	4.99	6.25	6.72	6.72	10.44	7.99	6.90	4.63	5.08	4.99	9.08	7.62	8.62	6.57	7.40	6.99
Schrock	12.07	12.71	10.53	8.62	8.49	8.26	12.52	5.45	7.99	8.35	8.35	9.71	10.53	9.08	10.07	8.88	9.48
Sagrain	10.71	8.62	8.62	8.53	8.71	8.89	10.89	10.53	7.90	8.62	8.98	9.26	9.26	11.62	9.30	9.44	9.37
Shallu	11.43	7.71	6.35	6.44	5.94	6.90	5.63	6.72	7.08	6.26	6.44	5.63	9.17	7.44	7.43	6.73	7.08
Darso	10.71	8.17	9.35	6.72	6.08	5.08	12.34	8.44	6.53	4.99	4.99	7.53	7.53	6.44	8.22	6.77	7.50
Feterita	—	—	—	—	—	—	—	—	7.26	5.08	6.08	6.90	8.44	8.35	7.26[1]	6.78[1]	7.02
White Kaffir	—	—	—	—	—	—	—	—	8.44	7.35	7.35	8.44	8.98	9.08	8.26[1]	8.29[1]	8.28
Dwarf Milo	—	—	—	—	—	—	—	—	6.35	6.44	7.71	11.25	8.89	6.99	7.65[1]	8.23[1]	7.94
Grohoma	—	7.71	7.26	10.98	9.35	8.71	12.98	9.53	7.53	6.35	8.98	8.62	9.98	8.26	9.35[2]	8.59	8.97
Sorgo:																	
Sumac	11.98	14.97	12.07	7.99	10.89	7.53	13.16	—	8.89	8.35	8.80	8.62	8.71	10.53	10.64	9.67[2]	10.16
Honey	—	—	—	—	—	—	—	—	9.44	8.17	16.61	14.07	11.34	8.44	12.46[1]	10.23[1]	11.35
Colman	10.53	14.43	12.80	10.62	7.53	7.90	10.16	—	10.79	7.71	10.25	10.71	10.89	8.80	10.42	10.03[2]	10.23

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[1] 3-year average.

[2] 6-year average.

TABLE 11—ANNUAL AND 7-YEAR AVERAGE YIELDS OF THRESHED GRAIN SORGHUM AND SORGO SEEDED ON TWO DATES AT THE RICE EXPERIMENT STATION, CROWLEY, LOUISIANA, FOR THE YEARS 1933-1939, INCLUSIVE*.

Variety	Yields of Grain per Acre, in Bushels, from First Cutting																
	1933		1934		1935		1936		1937		1938		1939		Average		
	Seeded		Seeded		Seeded		Seeded		Seeded		Seeded		Seeded				
	April 22	May 15	May 19	June 20	May 17	June 24	May 1	May 23	June 8	July 1	May 12	July 14	May 8	June 26	First Seeding	Second Seeding	First & Second Seedings
Grain Sorghum:																	
Hegari	6.81	.91	32.68	29.04	32.67	21.78	31.76	35.58	33.03	17.79	17.79	27.95	33.03	[1]	26.82	22.18 [3]	24.50
Chiltex	2.72	1.82	29.04	21.78	39.93	21.78	29.22	27.96	35.57	20.32	27.95	30.49	35.57		28.57	20.69 [3]	24.63
Schrock	13.16	6.35	32.68	21.78	36.30	36.30	40.66	20.32	33.03	20.32	35.57	30.49	43.20		33.51	22.59 [3]	28.05
Sagrain	8.62	4.08	29.04	21.78	32.67	32.67	36.84	43.20	30.49	25.40	30.49	27.95	33.03		28.74	25.85 [3]	27.30
Shallu	3.86	1.59	21.78	29.04	29.04	43.56	15.24	25.42	33.03	25.40	30.49	20.33	33.03		23.78	24.22 [3]	24.00
Darso	6.81	8.40	32.68	21.78	21.78	18.15	43.20	30.50	20.32	15.25	22.87	16.34	30.49		25.45	18.40 [3]	21.93
Feterita	—	—	—	—	—	—	—	—	35.57	25.40	20.33	20.33	25.41		27.10 [2]	22.87 [2]	24.99
White Kaffir	—	—	—	—	—	—	—	—	25.40	12.71	25.41	17.79	29.04		26.62 [2]	15.25 [2]	20.94
Dwarf Milo	—	—	—	—	—	—	—	—	27.95	17.79	20.33	17.79	33.03		27.10 [2]	17.79 [2]	22.45
Grohoma	—	2.04	14.52	14.52	25.41	21.78	33.04	10.16	22.87	17.79	35.57	15.25	40.66		28.68 [3]	13.59	21.14
Sorgo:																	
Sumac	10.21	5.45	21.78	10.90	18.15	10.89	48.28	—	20.32	12.71	20.33	20.33	35.57		24.95	12.06 [3]	18.51
Honey	—	—	—	—	—	—	—	—	15.25	10.16	17.79	15.25	22.87		18.64 [2]	12.71 [2]	15.68
Colman	7.94	2.27	18.16	7.26	18.15	18.15	17.78	—	22.87	12.71	15.25	12.71	30.49		18.66	10.62 [3]	14.64

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[1] No grain.

[2] 3-year average.

[3] 6-year average.

* Seventy per cent of dry weight of heads used to estimate amount of grain; 50 pounds used to estimate bushels of grain.

Most of the grain sorghums and all of the sorgos produced higher average forage yields from the first than from the second seeding. Of the grain sorghums, Hegari gave the highest 7-year average yield of green forage, and Schrock and Sagrain ranked second and third, respectively. Of the sorgos, the 7-year average yield of green forage was essentially the same for Sumac and Colman. In the 3-year period (1937-39), the average yield of Honey was 11.35 tons, for Colman 9.86, and for Sumac 8.98 tons per acre. The grain sorghums produced lower average yields of forage than did the sorgos, but higher yields of grain (Table 11).

Both grain sorghums and sorgos have higher average grain yields from the first than from the second seeding, except for Shallu (Table 11). Schrock gave the highest 6-year (1933-39) average grain yield, and Sagrain was second. The 6-year average yields ranged from 21.1 bushels for Grohoma to 28.1 bushels per acre for Schrock. In the 3-year period (1937-39), the average yield of Schrock was 32.5 bushels, Chiltex 30.0, and Sagrain 29.4 bushels per acre; whereas, the other varieties ranged in yield from 21.1 bushels for Darso to 28.5 bushels for Shallu. Shallu did not produce grain yields as high as most of the other varieties, but it is one of the best suited sorghum varieties for growing under prairie conditions. It produced grain of good quality under almost all conditions; whereas, the other varieties often failed to do so. The seed of Shallu was seldom attacked by insects either in the field or in storage, but seed of other varieties was often damaged by insects.

The 6-year average seed yield was for Sumac 18.5 bushels, and for Colman 14.6 bushels per acre. In the 3-year period (1937-39), the average seed yield was for Sumac 21.9 bushels, for Colman 18.8, and for Honey 16.5 bushels per acre.

In some years, as many as three grain crops were harvested from sorghums seeded in early April, and usually two from the May seedings, but yields for the first crop only are reported. In some seasons, the seed from the second crop, however, was of better quality than that from the first crop. After the first, and in some years after the second cutting, the rows were cultivated once to prevent weeds from becoming established before the aftermath had attained sufficient growth to take possession of the land. At harvest, the heads were removed, the stalks were cut at the ground, tied into bushels, and placed in large shocks to cure. This provided a rather good quality of roughage, most of which was readily eaten by livestock.

Soybean Varieties

In the 7-year period 1932-1939 (except 1937), approximately 60 soybean varieties and selections were grown in replicated row plots in rotation with other cultivated crops. Each year, approximately

400 pounds per acre of a complete fertilizer was applied to the land. In the past 10 or 15 years, for some unaccountable reason, very unsatisfactory yields of soybean seed have been produced on the Station. In the first 10 or 15 years after the Station was established, soybeans produced an abundance of normal seed. Since that time, insects have become more damaging, especially the velvet bean caterpillar; also diseases, and apparently other causes, have prevented the normal setting of seed. Because of this fact, no attempt was made to estimate seed yields, but in Table 12 the estimated yields of cured hay for 12 varieties are given. The yield of cured hay was estimated from the weight of green forage cut soon after the plants flowered.

In the 4-year period (1932-35), the average yield of cured hay was for Ototan 3012 pounds, for Biloxi 2778, for Laredo 2676, and for Barchet 2262 pounds per acre. The highest average yields for the years 1936, 1938, and 1939, was for Avoyelles 3588 pounds, for Palmetto 3473 pounds, for Monetta 3112, and for U. S. 71570 the average yield was 3023 pounds per acre. Each of these varieties produced higher average yields of cured hay than Barchet. However, Barchet was the most dependable variety for seed production.

TABLE 12—Annual and average of yields of cured hay for 12 soybean varieties grown at the Rice Experiment Station, Crowley, Louisiana, for the years 1932 to 1939, inclusive*

Variety	Yield of Cured Hay in Pounds per Acre							Average	
	1932	1933	1934	1935	1936	1938	1939	4 yrs. 1932-1935	3 yrs. 1936,1938-1939
Ototan	3896	2304	3040	2807	2478			3012	——
Biloxi	2052	3330	3272	2459	2091			2778	——
Laredo	2512	2885	3388	1917				2676	——
Mammoth Yellow	1684	1994	3233					——	
Barchet	1694	2962	2788	1604	1742	2718	3514	2262	2658
Delsta			3117	2478	2401				——
Tokyo			3465	2188	2091	2556	3398		2682
Mamloxi				1568	1936	883			——
Avoyelles					2865	3601	4298		3588
U. S. 71570					2168	3067	3833		3023
Palmetto					2788	3624	4008		3473
Monetta					2284	2927	4124		3112

* None seeded in 1937.

Summary

Rice is the principal crop grown in southwestern Louisiana, but cotton, corn, and soybeans also are grown extensively in the northwestern portion of the rice area, and to some extent throughout the area in which rice is grown. The land devoted to this work had been used for 25 years or more for commercial rice culture. The soil is Crowley silty loam and is typical of a large portion of the area devoted to rice. Up to the time the Station acquired this land, good crops of rice had been produced on it without the use of commercial fertilizers.

The experimental data obtained for cotton, corn, sorghum, and soybeans in the 15-year period, 1928-1942, are presented.

In the 15-year period 1928 to 1942, approximately 100 cotton varieties and strains were grown. In the 4-year period 1938-42, the highest average yield of lint cotton was from Dixie-Triumph 366, closely followed in average yield by Station Miller and Stoneville-2B.

In a fertilizer experiment using various formulas, the highest 10-year average yields of seed cotton were from the application of the 5-16-4, 5-8-8, and 7-8-4 formulas, respectively. The lowest average yields were from the application of the 5-0-4, 5-8-0, and 0-8-4, formulas, in the order given.

The results of 9 years indicate that 48 pounds of potash per acre applied before seeding, in a 5-12-8 mixture, are sufficient to produce maximum cotton yields. Potash applied as a side dressing was less profitable than when applied before seeding.

In the experiment, the highest 7-year average increase in yield of seed cotton was from plots that received phosphorous in bonemeal which was, however, closely approached in average yield by applications of basic slag, citratus, and superphosphate.

From two fertilizer formulas, 3-10-3 and 6-8-6, each applied at the rates of 150, 300, 450, and 600 pounds per acre, the highest 3-year average yield of seed cotton was from the 3-10-3 formula applied at the rate of 450 pounds per acre, and the yields from the applications of the 6-8-6 formula at the rate of 600 and 450 pounds per acre ranked second and third, respectively.

For the 5-year period beginning in 1932, approximately 20 varieties of corn were grown. The highest 5-year average yields were from Surecropper, Hastings Prolific, and Cock's Prolific, in the order named.

In a date-of-seeding experiment with corn covering a period of 6 years, plantings were made on March 1 and each 2 weeks thereafter until July 1. The highest 6-year average yield was from planting April

15, and the May 1 and April 1 plantings ranked second and third, respectively.

In a rotation consisting of cotton 2 years, and corn and soybeans 1 year, the 8-year average yield of seed cotton from the rotated plots was slightly under that of the check plots. The failure of the rotation to increase the yield of cotton and the low average production of corn clearly indicate that a rotation of this kind, under local conditions, would not be profitable.

Cotton and corn were grown in rows spaced 4, 5, and 6 feet apart, and the highest 5-year average yield of cotton was from the 4-foot spacing. The lowest average yield was that from that 6-foot spacing. The highest 5-year average yield of corn was from the plots in which the rows were spaced 4 feet apart, and the lowest yield was from the 5-foot spacing.

Approximately 20 varieties of grain sorghum and sorgo were grown for a period of 7 years. In yield of green forage the sorgos were superior to the grain sorghums with the Honey variety in the lead. For the 7-year period, Hegari led the grain sorghums, with Schrock and Sagrain second and third, respectively. The highest 6-year average grain yield was from Schrock with Sagrain second. Shallu did not produce grain yields as high as most of the other varieties, but the grain was of good quality under almost all conditions. The seed was seldom attacked by insects, either in the field or in storage. This was not often true of the other varieties. Of the sorgos, Sumac gave a higher average seed yield than Colman, and both exceeded Honey.

In the 11-year period from 1932 to 1942, approximately 60 soybean varieties and selections were grown. Because of damage from insects, diseases and other causes, the setting of seed was so poor that yields were not recorded. In yields of cured hay for the 4-year period 1932-35, Otootan, Biloxi, and Laredo ranked in the order given. Of the varieties grown for a period of 3 years (1936, 1938, 1939), Avoyelles ranked first in yield of cured hay with Palmetto, Monetta, and U. S. 71570, ranking second, third, and fourth, respectively. Barchet was the most consistent variety in the production of seed.

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Results Of Experiments With Rice In Louisiana

By

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Results Of Experiments With Rice In Louisiana[1]

By

J. MITCHELL JENKINS AND JENKIN W. JONES[2]

INTRODUCTION

Rice is the staple food of about half the world's population. Recent developments affecting rice supplies make it highly desirable to maintain and, if possible, increase acre yields in order to help meet the requirements of the Allied Nations for this important cereal. Total production can be increased either by (1) producing higher yields per acre, (2) increasing the acreage sown, or (3) a combination of these two methods. The first method is most logical, for higher yields may be produced on the present acreage without much, if any, extension of present irrigation systems or increase in farm equipment, whereas, a marked increase in acreage would require considerable expansion in irrigation facilities, and much additional farm machinery which is scarce. The purpose of this bulletin is to report results obtained at the Rice Experiment Station, Crowley, La., and to indicate ways in which the acre yields of rice can be maintained and even increased.

The commercial rice crop of the United States is produced in Louisiana, Texas, Arkansas, and California. In the 10-year period (1930-39), the average acreage and production for the United States was 943,000 acres and 45,712,000 bushels, or an average yield of 48.4 bushels per acre. In the same 10-year period, 48.3 and 40.6 percent, respectively, of the total acreage and production were in Louisiana, 21.7 and 23.3 percent in Texas, 17.5 and 20.4 percent in Arkansas, and 12.5 and 17.5 percent in California. There were 1,500,000 acres harvested in 1943 and total production was 70,025,000 bushels. This was the largest crop on record. In Louisiana, rice is the second most important farm crop, ranking next to cotton. The principal area of production is in the southwestern part of the State, in Acadia, Vermilion, Jefferson Davis, and Calcasieu parishes.

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[1] Submitted for publication August, 1944. The yields reported in this bulletin were obtained in cooperative investigations between the Louisiana Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

[2] Associate Agronomist, Division of Cereal Crops and Diseases, and Superintendent, Rice Experiment Station, Crowley, La., and Senior Agronomist, Division of Cereal Crops and Diseases.

SOIL AND CLIMATE

Soil

The soil at the Rice Experiment Station, Crowley, La., is brown or ash gray in color, and is classified as Crowley silt loam. The loam extends to a depth of 10 to 25 inches, with an average depth of about 16 inches. The subsoil consists of a mottled blue and yellow clay and both the surface and subsoil are rather impervious to water. Crowley silt loam is the predominating type of soil in the principal rice-producing section of southwestern Louisiana, and the results obtained at the Station are believed to be applicable in general to adjacent areas in which rice is grown.

Temperature

The winters in southwestern Louisiana are comparatively cool, with some freezing weather. The springs are warm, and in summer the average mean temperatures ranges from 81° to 82°F., and in the fall from 60° to 78°F. The warmest months are June, July, and August, with average maximum temperatures of 89°, 90°, and 91°F. respectively. The highest temperatures recorded at the Station during the 33-year period, 1910-1942, were 103°F. on June 27, 1930, and on August 10, 1935, and the lowest temperature was 9°F. on January 12, 1918.

Precipitation

The average annual precipitation for the 33-year period (1910-42) was 57.40 inches, with an annual range from 30.58 inches in 1924, to 106.64 inches in 1940. During the 33-year period, the months having the highest average precipitation were August 6.32, July 6.17, December 5.79, and January 5.23 inches; those having the least precipitation were October 3.39, April 3.87, and March 3.97 inches. Fortunately, the precipitation is so distributed from March through May, the seeding season, and from August through November, the harvest season, that there is seldom loss from excessive rainfall. An exception to this was August, 1940, during which the precipitation was so high (37.5 inches) as to cause much injury to the rice crop. The crop on the Rice Experiment Station was so irregular that the yield data obtained are not used in this bulletin. The humidity during the growing season is relatively high, being favorable for the development of fungus diseases, which cause some reduction in yield and in the quality of the crop.

Evaporation

The months of highest evaporation are May, June, July, and August. The total 33-year (1910-42) average annual evaporation from a free water surface was 50.89 inches, or 6.52 inches less than the average annual precipitation for the same period. The months of highest evaporation coincide with the period of most active growth and transpiration of the rice crop, and hence, during this period a shortage of fresh irrigation water for an extended period may result in much injury to the crop. The two main hazards to rice production in this area are drought and floods, or excessive rainfall during the harvest period. For more detailed information on climatic conditions at the Rice Experiment Station, see Chambliss and Jenkins (2)[3].

METHODS

In the experiments reported in this bulletin, the rice was grown in rectangular plots varying in size from one-sixtieth to one-tenth of an acre. In a few experiments, duplicate plots, but in most experiments systematically replicated, triplicate, or quadruplicate plots were used. The preparation of the seedbed, the date and rate of seeding, and the time and method of irrigation were the same each year for all plots within a given experiment.

Seedbed preparation consisted of late fall plowing, followed in the spring by disking, harrowing, and dragging to prepare a smooth seedbed except as otherwise indicated. The rice was sown with a grain drill at the rate of approximately 80 pounds per acre, except in one experiment. These, and other cultural practices used are based on results reported by Chambliss and Jenkins (2).

EXPERIMENTAL RESULTS

The investigations herein reported include results of varietal, date of seeding, irrigation, rotation, fertilizer, and pasture experiments. The yields for 1940 are not included because of injury to the crop as a result of the August flood.

Varieties

Thirteen varieties were grown in field plots replicated 3 or 4 times from 1937 to 1942. These may be divided into early, midseason, and late maturing groups. In the early group, Zenith and Early Prolific are medium-grain, and Edith, Lady Wright, and Delitus are long-grain varieties. In the midseason group, Caloro and Acadia are short-grain, Improved Blue Rose and Shoemed medium-grain, and Fortuna and Nira are long-grain varieties. The kernels of Delitus, Rexoro, Nira, and Iola are more slender than those of Edith and Lady Wright. Delitus is a scented rice. Rexoro, Fortuna, Nira, Shoemed, Iola, and Delitus are resistant to Race 1 of the leaf spot fungus (**Cercospora oryzae**), whereas, the other varieties listed are susceptible. The annual and average yields of the 13 varieties are given in Table 1.

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[3] Numbers in parentheses refer to Literature Cited p. 38.

TABLE 1—ANNUAL AND AVERAGE YIELDS OF RICE VARIETIES GROWN IN FIELD PLOTS, FROM 1937 TO 1942, CROWLEY, LOUISIANA

Group and Variety	C. I. No.	Acre Yields In Bushels						
		1937	1938	1939	1941	1942	4-year Average 1937-41	5-year Average 1937-42
Early group:								
Zenith	7787	45.3	31.7	37.4	37.7	51.0	38.0	40.6
Early Prolific	5883	38.7	25.9	40.5	39.2	41.6	36.1	37.2
Delitus	1206	35.8	23.8	27.4	27.5	——	28.6	——
Edith	2127	34.5	21.1	24.6	25.6	——	26.5	——
Lady Wright	5451	25.8	20.9	28.1	28.6	——	25.9	——
Midseason group:								
Improved Blue Rose	2128	48.6	31.5	46.5	44.4	32.9	42.8	40.8
Fortuna	1344	34.1	36.4	43.4	50.5	36.2	41.1	40.1
Nira	2702	32.1	32.6	52.1	52.9	16.4	42.4	37.2
Acadia	1988	21.2	26.2	43.4	55.3	34.7	36.5	36.2
Shoemed	3625	43.2	26.7	36.5	44.9	27.7	37.8	35.8
Caloro	1561-1	27.4	24.0	39.0	47.3	28.4	34.4	33.2
Late group:								
Rexoro	1779	37.4	39.5	54.6	58.4	49.8	47.5	47.9
Iola	4559	35.9	35.3	44.6	37.8	40.9	38.4	38.9

The 4-year average yield of all varieties listed in the early group was 31 bushels, in the midseason group 39 bushels, and in the late group 43 bushels per acre. The highest yields were secured from Rexoro and Improved Blue Rose both in the late group. In the early group, Zenith was somewhat better than Early Prolific, and both of these were also considerably more productive than Delitus, Edith, and Lady Wright, which ranked in the order listed.

In the midseason group, Improved Blue Rose and Fortuna yielded appreciably higher than Acadia, Shoemed, and Caloro. Nira produced an unusually low yield in 1942, which brought its 5-year average materially below that of Improved Blue Rose and Fortuna. Its average for other years is substantially equal to that of Improved Blue Rose. In the late group, Rexoro yielded much higher than Iola.

These results and others previously reported by Chambliss and Jenkins (3) and by Jones, et al., (7), indicate that Zenith and Early Prolific in the early group, Improved Blue Rose, Fortuna, Nira, and Acadia in the midseason group, and Rexoro in the late group, are well adapted for growing in Louisiana. These include varieties of different grain types and time of maturity. Among them, growers should be able to choose varieties so as to distribute the harvest over a relatively long period, and to benefit by having rice of different grain types to market each year.

Dates of Seeding

On Dry Land

Four rice varieties were seeded in duplicate plots with a grain drill at intervals of about 2 weeks from March 15 to June 15 during the 6-year period 1933 to 1938, and two additional varieties were included during the 5-year period 1934 to 1938. There were a few unavoidable omissions in the June seedings for both periods. The annual and average yields, dates of maturity, and number of days from seeding to maturity are shown in Table 2.

The highest average yields (6 years) for Fortuna, Rexoro, Blue Rose, and Caloro were from seeding about April 1, and for Early Prolific and Nira (5 years) from seeding May 15.

No variety yielded best on the average from seeding at the earliest date, about March 15, nor from the latest seeding on June 15. The yearly variations are very large, however, suggesting that in some seasons good yields may be expected even though seeding is somewhat earlier or later than the best average dates.

Also, some varieties are less sensitive than others to variation in date of seeding. Thus, relatively good yields were secured from Fortuna and Nira for all dates of seeding while those from the June 15 seeding of Blue Rose and Caloro were very low. Early Prolific seems to be especially sensitive to very early seeding since it produced low yields every year from seeding around the middle of March, as compared with around April 1 or April 15, and generally low as compared with all dates of seeding up to and including the middle of May. Yet Early Prolific is sown on commercial fields before the other varieties.

The last column of Table 2 gives the average dates of maturity and the number of days from seeding to maturity. When seeded on or near April 1, Early Prolific, Fortuna, Nira, and Caloro mature early and approximately in the order named, and Blue Rose and Rexoro two to three weeks later. When seeded about May 15, however, Blue Rose ripens about the same time as Fortuna and Nira, and Caloro ripens even earlier than Early Prolific. This is because Blue Rose and Caloro are more sensitive than the other varieties to length of day, and hence, tend to head and ripen more rapidly as the days become shorter. Growers who wish to extend the harvest season over a long period should take this relation into account. They would gain very little, for example, by late seeding of Blue Rose or Caloro without seeding so late as to materially reduce yields; whereas, the harvest period could be considerably lengthened by seeding the other varieties on successive dates. It should be noted, however, that Nira, Fortuna, and Rexoro may not mature before frost if seeded too late. This means that when, for any reason, it is desirable to seed very late in the spring, it is safer to use

TABLE 2—ANNUAL AND AVERAGE YIELDS OF SIX VARIETIES OF RICE GROWN IN DATE-OF-SEEDING EXPERIMENTS, FROM 1933-1938, AT CROWLEY, LA.

Variety	Average Date of Seeding	Acre Yields in Bushels								Average	
								Average			
		1933	1934	1935	1936	1937	1938	1933 to 1938	1934 to 1938	Date of Maturity	No. Days from Seeding to Maturity
Fortuna	March 17	55.9	35.3	66.7	33.4	45.5	29.4	46.0	42.1	Aug. 27	164
	April 3	53.9	53.6	66.1	39.3	50.5	27.4	48.5	47.4	Sept. 3	152
	April 15	51.2	39.4	52.4	37.0	39.3	23.8	40.5	38.4	Sept. 12	149
	May 3	43.2	35.0	69.9	31.1	36.2	21.8	39.6	38.8	Sept. 22	141
	May 17	41.2	37.7	64.9	26.1	22.5	32.1	37.4	36.7	Oct. 3	139
	June 1	46.6	35.0	47.4	26.1	23.1	27.1	33.7	31.7	Oct. 20	141
	June 15	25.3	45.3	34.9	——	25.6	25.1	31.2	——	Oct. 26	133
Rexoro	March 17	42.6	47.7	45.5	34.1	27.4	33.7	38.5	37.7	Sept. 22	189
	April 3	59.2	43.3	88.0	34.7	28.7	29.8	47.3	44.9	Sept. 25	180
	April 15	48.5	36.0	56.8	32.7	28.7	35.4	39.7	37.9	Oct. 7	175
	May 3	50.5	50.2	86.7	35.0	35.6	20.2	46.4	45.5	Oct. 19	169
	May 17	46.6	44.6	73.6	24.8	26.2	27.1	40.5	39.3	Oct. 29	165
	June 1	39.2	43.0	65.5	——	43.0	24.5	43.0	——	Nov. 7	159
	June 15	28.0	37.0	26.8	00.0	21.8	00.0	19.0	——	Nov. 14	152
Blue Rose	March 17	49.2	38.7	31.8	40.3	49.3	36.7	41.0	39.4	Sept. 19	186
	April 3	58.5	32.7	69.9	40.0	53.0	29.1	47.2	44.9	Sept. 22	172
	April 15	31.9	22.8	49.9	28.1	36.2	37.7	34.4	34.9	Sept. 25	163
	May 3	33.9	32.4	82.3	28.1	51.1	27.4	42.6	44.3	Sept. 26	146

	May 17	33.9	32.7	69.9	24.8	42.4	29.8	38.9	39.9	Oct. 3	139
	June 1	31.3	24.5	47.4	18.5	50.5	31.7	34.0	34.5	Oct. 10	131
	June 15	27.9	31.4	46.8	18.8	33.7	17.8	29.4	29.7	Oct. 19	126
Caloro	March 17	53.9	50.3	36.2	23.5	38.7	6.3	34.8	31.0	Sept. 3	170
	April 3	67.2	45.6	75.5	27.1	53.6	24.1	48.8	45.2	Sept. 4	154
	April 15	41.9	36.4	64.9	17.9	42.4	29.8	38.9	38.3	Sept. 7	145
	May 3	39.9	34.3	73.0	14.9	39.9	20.8	37.2	36.6	Sept. 7	127
	May 17	31.9	24.4	68.6	28.8	26.8	18.5	32.2	32.2	Sept. 17	123
	June 1	25.3	24.4	51.8	7.3	37.4	18.2	27.4	27.8	Sept. 21	112
	June 15	35.9	19.5	23.1	4.6	19.3	11.2	19.0	15.5	Sept. 29	106
Early Prolific	March 17	—	19.3	45.5	19.8	32.4	27.1	—	28.9	Aug. 7	143
	April 3	—	26.4	70.5	31.4	45.5	23.8	—	39.5	Aug. 15	134
	April 15	—	30.4	57.4	31.4	39.3	29.4	—	37.6	Aug. 23	130
	May 3	—	36.7	72.4	23.8	48.7	26.1	—	41.5	Sept. 9	129
	May 17	—	28.4	64.2	27.1	34.3	32.4	—	37.3	Sept. 19	124
	June 1	—	26.8	45.5	20.2	38.0	23.8	—	30.9	Sept. 28	119
	June 15	—	28.1	35.6	17.5	29.3	16.5	—	25.4	Oct. 12	119
Nira	March 17	—	35.7	56.8	32.1	28.1	25.8	—	35.7	Aug. 29	165
	April 3	—	41.0	58.6	31.4	47.4	25.4	—	40.8	Sept. 5	155
	April 15	—	31.4	45.5	27.8	51.8	26.8	—	36.7	Sept. 11	149
	May 3	—	43.0	69.2	27.1	39.3	22.8	—	40.3	Sept. 25	145
	May 17	—	45.0	77.3	26.1	33.7	39.7	—	44.4	Oct. 1	143
	June 1	—	37.7	55.5	24.8	42.4	32.1	—	38.5	Oct. 23	144
	June 15	—	—	54.9	—	35.6	10.9	—	33.8	Nov. 3	141

Blue Rose, Early Prolific, or Caloro. Beachell (1) and Jenkins (5) have reported in detail on the reaction of varieties to date of seeding and the effect of length of day and the reader is referred to their reports for additional information.

In Water

During the 4-year period (1934-38), five varieties of rice were sown broadcast in the water in triplicate plots on 3 different dates, about April 1, May 1 and May 15 each year. The stands were so poor in 1935 that yields were not recorded. The annual and average yields are given in Table 3.

TABLE 3—ANNUAL AND AVERAGE YIELDS OF FIVE RICE VARIETIES SOWN BROADCAST IN THE WATER IN A DATE-OF-SEEDING EXPERIMENT, FROM 1934 TO 1938[1], AT CROWLEY, LOUISIANA

Variety	Date of Seeding	Yields Per Acre In Bushels					
		1934	1936	1937	1938	3-year Average 1934-37	4-year Average 1934-38
Fortuna	April 1	23.2	36.0	40.3	—	36.2	—
"	May 1	35.8	20.5	18.8	21.8	25.0	24.2
"	May 15	37.5	9.2	40.3	13.5	29.0	25.1
Average		32.1	21.9	33.1	17.6	29.0	26.2
Rexoro	April 1	29.7	34.6	43.0	—	35.8	—
"	May 1	41.1	14.1	26.9	13.5	27.4	23.9
"	May 15	42.7	4.2	34.9	6.7	27.3	22.1
Average		37.8	17.6	34.9	10.1	30.1	25.2
Blue Rose	April 1	30.2	53.6	44.4	—	42.7	—
"	May 1	37.6	41.7	37.7	21.8	39.0	34.7
"	May 15	37.5	1.2	32.3	26.9	23.7	24.5
Average		35.1	32.2	21.5	24.4	29.6	28.3
Early Prolific	April 1	22.1	24.0	16.1	—	20.7	—
"	May 1	29.1	32.5	16.1	13.5	25.9	22.8
"	May 15	30.2	14.1	32.3	23.6	25.5	25.1
Average		27.1	23.5	21.5	18.5	24.0	22.7
Caloro	April 1	42.6	33.2	45.7	—	40.5	—
"	May 1	47.6	31.8	21.5	35.4	33.6	34.1
"	May 15	49.1	16.9	24.2	23.6	30.1	28.5
Average		46.5	27.3	21.5	29.4	31.8	31.2

In 1938, no stands were obtained from the April 1 seeding due to heavy rains and low temperatures soon after seeding, or before the seedlings were firmly established. The motion of the water covered the seed with soil and, as is usual when this happens with rice seeded in the water, the seed germinated very poorly or not at all.

The highest 3-year (1934, 1936, 1937) average yield for each variety except Early Prolific was from seeding April 1. For the 4-year period (1934, 1936, 1938), the average yields of Fortuna, Rexoro, and Early Prolific were essentially the same from seeding on May 1 and May 15, but for Blue Rose and Caloro the average yields from the May 1 seeding were much higher than for seeding on May 15.

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[1] Failed to get satisfactory stands in 1935.

Blue Rose and Caloro gave much higher yields than Rexoro and Fortuna in this experiment, though as noted above, the latter, when sown with a grain drill on dry land, yields as well or better than Blue Rose, and usually much better than Caloro. This difference in behavior may be due in part to better germination of Blue Rose and Caloro seed when sown in the water, and to better emergence of the seedlings through the water than for the other varieties.

METHODS OF IRRIGATION

Dates of Submergence

Five rice varieties were grown for a 6-year period in an experiment to determine the effect on weed control and on yields of submerging the land 10, 20, 30, and 40 days after the seedlings emerged. The plots were replicated 3 times for each treatment. The annual and average yields are given in Table 4.

TABLE 4—ANNUAL AND AVERAGE YIELDS OF FIVE VARIETIES OF RICE GROWN IN A DATE-OF-SUBMERGENCE EXPERIMENT, FROM 1933 TO 1938, AT CROWLEY, LOUISIANA

Variety	Days Submerged After Seedling Emergence	Yields Per Acre In Bushels						
		1933	1934	1935	1936	1937	1938	6-year Average 1933-38
Fortuna	10	53.3	44.9	37.1	37.1	41.0	33.2	41.1
	20	44.4	50.5	35.3	36.9	42.2	41.0	41.7
	30	43.7	50.9	37.6	35.5	37.1	41.2	41.0
	40	34.4	48.2	29.5	24.4	41.5	36.2	35.7
Rexoro	10	48.8	50.2	33.0	40.1	35.3	35.7	40.5
	20	45.7	52.8	38.7	34.6	36.0	44.0	42.0
	30	42.2	42.4	39.0	27.9	30.6	42.2	37.4
	40	30.6	44.2	37.1	22.4	34.1	39.4	34.6
Blue Rose	10	35.8	36.4	31.1	33.0	33.6	34.6	34.1
	20	32.3	44.9	34.3	34.3	38.4	44.5	38.1
	30	26.6	41.9	34.6	28.6	40.5	42.9	35.8
	40	19.9	39.6	35.3	25.1	45.6	38.7	34.0
Early Prolific	10	20.6	44.0	27.4	35.5	34.1	27.2	31.5
	20	21.3	47.9	33.2	46.1	41.7	41.2	38.6
	30	20.3	40.1	29.3	34.1	43.8	36.6	34.1
	40	16.8	36.4	32.7	25.8	38.0	30.0	30.0
Caloro	10	30.3	44.0	21.0	29.0	33.2	25.1	30.4
	20	24.4	47.2	26.3	36.4	28.6	30.2	32.2
	30	23.1	46.1	20.7	18.7	23.9	26.3	26.4
	40	18.2	44.9	23.7	9.9	25.1	22.6	24.1

The highest 6-year (1933-38) average yields for each variety were obtained on land submerged 20 days after the seedlings had emerged, and for Fortuna, Rexoro, and Caloro the yields from the 10-day submergence ranked second. In most plots, grasses increased and water weeds decreased in proportion to the length of the dry period between seedling emergence and submergence of the land. In other words, early submergence of the land controlled grasses, but favored the growth of water weeds. In the absence of grasses and other semi-aquatic weeds, delaying the submergence until 30 days after seedling emergence and in some years as much as 40 days, caused practically no reduction in yields. The results indicate, that the control of grasses is more important than the control of water weeds, since the highest average yields were in general obtained by early submergence of the land.

Discontinuous vs. Continuous Submergence

The Fortuna variety was grown in plots replicated 3 times during the 6-year period (1934-39) to determine the effect of different methods of irrigation on yields. Four methods were compared, namely: (1) the land was submerged 10 days after seedling emergence and water was held on the land continuously until the plots were drained prior to harvesting; (2) the land was submerged 10 days after seedling emergence, drained 3 weeks later, and after it had dried, was again submerged and water was held until the plots were drained prior to harvesting; (3) the land was submerged at the time the seedlings emerged and the water was allowed to evaporate, and when the land was dry it was again submerged and water was held until just prior to harvesting; and (4) the land was submerged at the time the seedlings emerged, the water was allowed to evaporate, and when the land was dry it was again submerged, drained 4 weeks later, and when dry it was again submerged and water was held until just prior to harvesting. The annual and average yields are shown in Table 5.

TABLE 5—ANNUAL AND AVERAGE YIELDS OF FORTUNA RICE GROWN BY DIFFERENT IRRIGATION METHODS FROM 1934 TO 1939, AT CROWLEY, LOUISIANA

Irrigation Methods	Acre Yields In Bushels						
	1934	1935	1936	1937	1938	1939	6-year Average 1934-39
Number 1	41.9	24.2	28.0	36.4	60.2	41.4	38.7
Number 2	44.4	21.4	31.4	27.8	47.7	25.6	33.1
Number 3	31.4	15.4	28.6	27.5	51.6	38.4	32.1
Number 4	34.8	15.0	33.0	23.9	37.2	32.6	29.4

On the basis of the 6-year average, Method 1 produced 5.6 bushels more than Method 2, which was second best. The results were somewhat variable from year to year, however. The lowest yields were secured by the fourth method. These results indicate that under the conditions existing at Crowley, La., early continuous submergence is, in general, better practice than intermittent drying and submergence of the land.

Holding Water on Uncropped Land

Some growers have expressed the opinion that higher yields may be secured if the land is kept submerged during a portion of the uncropped or resting period. In 1936, an experiment was started to obtain information on this problem. The treatment of the rice stubble, or uncropped land, was as follows: (1) In the fall after the rice was harvested, water was held on the stubble land during the winter, summer, and early fall months. The land was then drained and plowed in late fall and left in the rough until the seedbed was prepared the following spring; (2) water was first put on the stubble land after late fall plowing and held there until March 1, and then the land was allowed to dry for seedbed preparation; and (3) no water was held on the stubble land during any part of the uncropped season. The land was plowed in late fall of the idle year according to the usual practice in the rice area. The Fortuna variety was grown and the plots were replicated 3 times. The annual and average yields are given in Table 6.

TABLE 6—ANNUAL AND AVERAGE YIELDS OF FORTUNA RICE GROWN IN AN EXPERIMENT TO STUDY THE EFFECT ON YIELDS OF HOLDING WATER ON STUBBLE LAND, FROM 1936 TO 1942, AT CROWLEY, LOUISIANA

Treatment	Acre Yields In Bushels							
	1936	1937	1938	1939	1941	1942	6-year Average 1936-42	Average Increase or Decrease
No. 1	22.5	23.0	25.1	27.8	29.1	27.8	25.9	-0.3
No. 2	25.6	28.9	23.1	27.4	31.4	28.6	27.5	1.3
No. 3	18.7	28.9	25.9	26.8	32.6	24.0	26.2	—

The 6-year (1936-42) average yields for the three treatments were essentially the same. The results indicate that the holding of water on uncropped land has neither a beneficial nor a detrimental effect on the yields of rice. In dry periods, however, the holding of water on stubble land is favorable for the growth of native pasture plants.

ROTATION EXPERIMENTS

The rice crop, like other cereals, responds to good cultural methods and rotation systems. In Louisiana, the rice crop is normally grown in alternate years, or once in 3 years, on land that during the resting period is in cultivated fallow or left in stubble pasture for one or two years. Since rice is the main cash crop grown, short-time rotations are generally used by growers. It seemed desirable to determine the relation of rotations to yields of rice and also to compare rotations of different length. Accordingly, some experiments to compare yields in 2-year, 3-year, and 10-year rotations were begun in 1934, and in 4-year rotations in 1936. The Fortuna variety was used in all but the 10-year rotation, and the plots were replicated 3 or 4 times. All except the 10-year rotations were located in the same field.

Two-year Rotations

The 2-year rotations consisted of growing rice in alternate years in rotation with (1) cultivated summer fallow, (2) stubble pasture, (3) Italian rye grass grown on stubble pasture, (4) cotton, (5) *Crotalaria spectabalis*, (6) soybeans, (7) red clover on stubble pasture, and (8) soybeans followed in the fall by bur clover. The ryegrass, red clover, and bur clover were sown on stubble pasture land in the fall. The annual and average yields are given in Table 7.

TABLE 7—ANNUAL AND AVERAGE YIELDS OF FORTUNA RICE GROWN IN 2-YEAR ROTATIONS FROM 1934 TO 1942, AT CROWLEY, LOUISIANA

Year	Acre Yields In Bushels Of Rice In Rotation With:							
	Cultivated Summer Fallow	Stubble Pasture	Italian Ryegrass Grown On Stubble Pasture	Cotton	*Crotolaria Spectabalis*	Soybeans	Stubble Pasture and Red Clover [1]	Soybeans and Bur Clover
1934	67.0	62.4	68.4	70.2	66.3	61.3	58.5	57.4
1935	76.0	61.8	66.1	60.6	65.7	72.4	73.8	76.2
1936	29.2	27.4	30.6	26.7	29.9	33.9	36.4	33.2
1937	36.7	36.7	46.0	24.2	37.1	44.6	43.8	44.6
1938	47.7	51.6	51.0	32.6	44.1	42.7	47.1	43.2
1939	48.7	50.3	54.2	38.5	52.7	51.2	51.2	52.3
1941	37.6	37.7	42.2	27.7	36.6	34.5	40.2	39.9
1942	42.2	43.8	39.2	9.9 [2]	39.8	42.3	46.9	38.0
Average	48.1	46.5	49.7	36.3	46.5	47.9	49.7	48.1

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[1] Soybeans followed by alsike clover were grown in this rotation in 1934, 1935, and 1936.

[2] Oats substituted for cotton the preceding year.

The highest 8-year average yield (49.7) bushels per acre) was following Italian ryegrass and red clover on stubble pasture. Rice following cultivated fallow, and that following soybeans plus bur clover ranked second. The lowest average yield (36.3 bushels per acre) was following cotton (oats in one year) dusted with calcium arsenate. The low average yield of rice in this rotation, in 1942, was due to the residual effect of calcium arsenate and not to the cotton (or oat) crop. The 8-year average yield of soybeans ranged from 3.4 to 3.9 bushels per acre, and the 7-year average (1933-41) yield of seed cotton was 136.7 pounds per acre. The yields were too low to be profitable.

In addition to the above, Fortuna rice was grown in alternate years on fall-plowed land seeded and not seeded to Italian ryegrass during the 6-year period (1936-42). The 6-year average yields were 40.9 bushels after Italian ryegrass and 42.7 bushels per acre on land without ryegrass. The seeding of ryegrass on plowed land in the fall, therefore, resulted in a small decrease in the average yield of rice.

Three-year Rotations

In the 3-year rotation experiment, rice was grown in rotation with cotton and soybeans each one year. The sequence of crops was rice, cotton, and soybeans. The cotton was dusted with calcium arsenate to control boll weevil, and each treatment was replicated 4 times. The annual and average yields for a 7-year period (1934-41) are shown in Table 8.

TABLE 8—ANNUAL AND AVERAGE YIELDS OF FORTUNA RICE, SEED COTTON, AND SOYBEANS GROWN IN A 3-YEAR ROTATION FROM 1934 TO 1941, AT CROWLEY, LOUISIANA

Year	Acre Yields		
	Seed Cotton Pounds	Soybeans Bushels	Rice Bushels
1934	95	1.9	68.4
1935	151	1.6	54.2
1936	57	2.2	54.3
1937	43	3.3	37.4
1938	7	2.8	28.1
1939	89	2.1	49.9
1941	98	2.5	29.2
Average	77.1	2.3	45.9

The average yield of seed cotton was 77.1 pounds, of soybeans 2.3 bushels, and of rice 45.9 bushels per acre. It is apparent that in this rotation the average yields of cotton and soybeans were too low to be profitable, and the average yield of rice was less than that obtained in the better 2-year rotations in the same field. The lower yield of rice was most likely due to the calcium arsenate used on the cotton. It appears, therefore, that so far as the yield of rice is concerned, it is better practice to grow it in a 2-year rotation, with stubble pasture supplemented with either ryegrass or clover in the fall than in a 3-year rotation of this kind.

Four-year Rotations

The 4-year rotations consisted of two successive rice crops following 2 years in cotton fertilized and in cotton not fertilized, and following 2 years in pasture fertilized, and in pasture not fertilized. The plots were replicated 3 times. On the fertilized cotton and pasture plots a 5-15-5 fertilizer was applied at the rate of 480 pounds per acre. The 5-year (1936-41) average yield of seed cotton on the fertilized plots was 1098 pounds, and on plots not fertilized 77 pounds per acre. The annual and average yields of the first and second crops of rice grown on the fertilized and not fertilized cotton and pasture land in successive years are given in Table 9.

TABLE 9—ANNUAL AND AVERAGE YIELDS OF FORTUNA RICE GROWN IN 4-YEAR ROTATIONS, FROM 1936 TO 1942, AT CROWLEY, LOUISIANA

Preceding Crop and Treatment	Acre Yields In Bushels						Average	
	1936	1937	1938	1939	1941	1942	1936-'42	Increase or Decrease*
Cotton:								
Fertilized	50.5	33.6	42.6	36.6	37.6	21.3	37.0	-6.7
Not Fertilized	51.4	31.1	29.1	33.6	38.0	35.1	36.4	-7.3
Average	51.0	32.3	35.8	35.1	37.8	28.2	36.7	
Pasture Stubble:								
Fertilized	43.6	43.3	54.7	44.4	45.6	35.4	44.5	0.8
Not Fertilized	44.6	36.9	47.6	42.9	49.2	41.0	43.7	
Average	44.1	40.1	51.1	43.6	47.4	38.2	44.1	

* As compared with the yield on pasture stubble not fertilized.

The 6-year (1936-42) average yields following cotton fertilized and not fertilized were essentially the same, and so were the average yields following fertilized and not fertilized stubble pasture. In other words, fertilizing the cotton or pasture apparently had no beneficial residual effect on the yields of the succeeding rice crops. It is pertinent to note, however, that the rice grown in rotations with pasture on the average produced 7.4 bushels per acre more than when it followed cotton, which as in the preceeding experiment was dusted with calcium arsenate.

Ten-year Rotations

In the 10-year rotations, which were started in 1934, the plan is to grow 5 consecutive annual rice crops following 5 years of continuous cropping to (1) cotton, (2) native pasture, (3) corn and soybeans, and (4) improved pasture in which clovers and lespedeza are sown. The soybeans are planted in the corn during the last cultivation, and plowed under as a green manure crop. The native and improved pastures are clipped and the clippings left on the land. The first cycle in these rotations is now completed. Five consecutive rice crops have been grown following 5 years in each of the above treatments, but the 1940 crop was destroyed by floods. The annual and average yields of rice are shown in Table 10. The average yield of seed cotton for the 5-year period (1934-39) preceding the rice crops was 584 pounds, and of corn 9.3 bushels per acre. During this same period, rice grown every year produced an average yield of 30.5 bushels per acre or more than twice as many pounds as corn.

TABLE 10—ANNUAL AND AVERAGE YIELDS OF REXORO RICE GROWN IN A 10-YEAR ROTATION FROM 1939 TO 1943, AT CROWLEY, LOUISIANA

Crop For The 5 Years Preceding Rice	Acre Yields In Bushels				
	1939	1941	1942	1943	4-year Average
Cotton	49.2	14.7	36.1	28.4	32.1
Native pasture	71.2	28.6	46.5	41.9	47.1
Corn and soybeans	63.6	31.1	45.1	42.4	45.6
Improved pasture	74.5	33.1	46.4	40.8	48.7
Average	64.6	26.9	43.5	38.4	43.4

The highest 4-year average yield of rice was 48.7 bushels per acre following improved pasture. The average yield following native pasture was 47.1 bushels; after corn plus soybeans, 45.6 bushels; and after dusted cotton 32.1 bushels per acre. Again the highest average yields were obtained following pasture.

These results indicate that improved pastures may be developed and used for a period of 4 to 5 years, and the land then cropped to rice continuously for 4 years or more without any appreciable reduction in the average yield of rice as compared to cropping in alternate years. The improved pasture when well established should be much more valuable for grazing purposes during the resting period than is native stubble pasture, as commonly used.

Residual Effect of Calcium Arsenate on Yields

Fortuna rice was grown in alternate years for a 7-year period (1935-42) in rotation with (1) cotton dusted with calcium arsenate, (2) cotton not dusted, and (3) stubble pasture. The annual and average yields of the rice are shown in Table 11.

TABLE 11 -- ANNUAL AND AVERAGE YIELDS OF FORTUNA RICE GROWN IN ROTATION WITH COTTON DUSTED AND NOT DUSTED, AND WITH STUBBLE PASTURE, FROM 1935 TO 1942, AT CROWLEY, LOUISIANA

Year	Acre Yields In Bushels Of Rice Following:		
	Cotton		Stubble Pasture
	Dusted	Not Dusted	
1935	45.7	68.2	48.4
1936	31.0	31.6	31.6
1937	25.0	47.2	38.2
1938	27.7	39.6	37.4
1939	39.1	59.0	49.5
1941	27.7	35.5	34.1
1942	27.4	34.6	34.9
Average	31.9	45.1	39.2

Each year, the yield of rice was higher following cotton not dusted than following cotton dusted, the average difference being 13.2 bushels per acre. A reduction in yield on dusted cotton land occurred even though only a few straight-head plants were observed, due presumably to the calcium arsenate having been washed off the cotton plants into the soil. The average yield of rice after stubble pasture was 39.2 bushels, or somewhat less than the yield following non-dusted cotton.

Continuous Cropping

Practical experience indicates that rice yields on reasonably fertile soils usually decrease in successive years when grown continuously on the same land. At the Rice Experiment Station, a tenth acre plot has been continuously cropped to rice since 1893, 1942 being the 49th crop. Yields have been recorded each year for the past 30-year period (1913-1942). From 1913 to 1918, inclusive, the Honduras variety, and from 1919 to 1942, inclusive, the Wataribune variety has been grown. The annual and average yields grouped by 5-year periods are shown in Table 12.

TABLE 12—ANNUAL AND 5-YEAR AVERAGE YIELDS OF RICE GROWN CONTINUOUSLY ON THE SAME LAND, FROM 1913 TO 1942, INCLUSIVE, AT CROWLEY, LOUISIANA

Year And Yield Per Acre In Bushels											
Year	Bu.	Year	Bu.	Year	Bu.	Year	Bu.	Year	Bu.	Year	Bu.
1913	51.1	1918	27.2	1923	13.6	1928	25.8	1933	32.9	1938	27.1
1914	49.4	1919	24.7	1924	22.9	1929	21.6	1934	21.3	1939	31.8
1915	27.8	1920	27.2	1925	28.9	1930	26.9	1935	29.6	1940	—
1916	18.2	1921	28.1	1926	27.8	1931	33.6	1936	24.4	1941	33.8
1917	21.3	1922	15.5	1927	35.3	1932	26.9	1937	16.4	1942	35.1
Average	33.6		24.5		25.7		27.0		24.9		32.0

The 5-year average yields for each successive 5-year period are 33.6, 24.5, 25.7, 27, 24.9 and (omitting 1940 when the crop was severely damaged by floods) 32.0 bushels per acre, respectively. The average yields grouped by 10-year periods are as follows: 1913-22, 29.1 bushels; 1923-32, 26.3 bushels; and 1933-42 (omitting 1940), 28 bushels per acre. These averages are not markedly different, the difference between the first and last 5-year periods being only 1.6 bushels per acre, and between the first and last 10-year periods only 1.1 bushels per acre. The average yield for the 29-year period is 27.8 bushels.

The results suggest that with good cultural practices and weed control, average yields of from 25 to 30 bushels per acre may be expected for a period of 30 years or more on continuously cropped Crowley silt loam.

In this connection, it is of interest to note that in a number of Oriental countries, the average yields of rice, on land not fertilized and largely continuously cropped, ranges from 21 to 34 bushels per acre. For example, the 5-year (1930-31 to 1934-35) average yield for Indo-China is 21 bushels, for the Philippine Islands 22 bushels, Burma 25 bushels, British India 28 bushels, the Netherland Indies 30 bushels, and Thailand 32 bushels per acre. These figures indicate that most rice soils, when continuously cropped and kept well weeded, are capable of maintaing rather low average yields for a long period. Rice has been grown for hundreds of years in some of these countries, and yet, the soil is not exhausted, though the average yields are low as compared to countries like Japan and China in which compost, green manure crops, and fertilizers are often used.

It is also of interest to note that on Crowley silt loam, cropped in alternate years, with good cultural practices, the average yield of rice is 50 bushels per acre, as compared with 28 bushels on continuously cropped land. Based on these yields, in a 30-year period, an acre cropped in alternate years would produce a total of 750 bushels, and when continuously cropped 840 bushels, a difference of 90 bushels in favor of continuous cropping. It is of course much more economical, on relatively cheap land which can in alternate years be used for cattle pasture and provide some income above taxes, to prepare the land, seed, irrigate, and harvest 15 good crops in 30 years than it is to grow a relatively low-yielding crop each year. Therefore, in commercial rice production in Louisiana, alternate cropping is practiced because the crop can be produced at a lower cost per acre and per bushel by this method. In much of the Orient, land is expensive, labor is cheap, modern machinery is not usable, and intensive rather than extensive methods of production are used. With these conditions, more rice can be produced by growing it continuously on the same land than in rotation with other crops. Also, rice is the favorite article of food, and when grown in rotation it usually is with other food crops such as wheat, barley, corn, sugarcane, legumes and vegetables.

In all the rotations, for which results are reported, the highest average yields were, in most cases, obtained by growing rice on stubble or on improved pasture land. The former is the common practice in Louisiana for, as a rule, the returns on such intertilled crops as cotton, corn, and soybeans, grown during the resting period have not been entirely satisfactory whereas rice farmers always receive some annual cash income from cattle grazed on stubble land. The native stubble pastures, however, have a rather low carrying capacity, especially during cold and dry periods, and hence, the more general use of improved pastures should be encouraged. Jenkins (6) reported that the seeding of Bermuda and Dallis grasses, white clover, and common lespedeza on pastures and the use of lime and fertilizers improved the growth of pasture plants materially, and the carrying capacity of the pastures. It takes time to establish a good pasture in the rice area, but results indicate that from the standpoint of both rice and cattle production, the change to improved pasture should be profitable.

FERTILIZER EXPERIMENTS

The results of fertilizer experiments conducted at the Rice Experiment Station in earlier years have been reported by Chambliss and Jenkins (2). They are not especially encouraging, for only small or no increases in yield were obtained from the application of acid phosphate, ammonium sulphate, sodium nitrate, or cottonseed meal when applied alone. Potassium sulphate applied alone and with ammonium sulphate, and dried blood alone, gave small increases in average yields. After a lapse of several years during which time additional land was acquired, more extensive experimental work with fertilizer was undertaken. Most of the experiments were conducted on the land acquired in 1930, which, prior to starting these experiments, was fallowed for three or more years to eradicate red rice. Consequently, this area is more productive than the original station land on which other fertilizer experiments were located. Contrary to usual expectation, the response of the rice crop to fertilizers is better on the productive than on the less productive original station land. This confirms earlier conclusions made by Sturgis (9). The results with the same fertilizer, for example, may agree, but the extent of the increase varies with the relative productivity of the land.

The experiments include studies of the effect of compost, straw with and without fertilizer, complete fertilizers with phosphorous from different sources and applied at different rates, residual effect of phosphorous, ammonium sulphate and ammophos applied at different dates, complete and incomplete fertilizer formulas, and rates of application of complete and incomplete fertilizers on the yields of rice. The grade or formula of a mixed fertilizer indicates the amount of the plant food elements nitrogen, phosphoric acid, and potash present in the fertilizer. Thus, an 8-10-6 fertilizer contains 8 percent of nitrogen, 10 percent of phosphoric acid, and 6 percent of potash, or a total of 24 percent of these plant food elements. A complete fertilizer is one containing the 3 principal elements of plant food, nitrogen, phosphorous and potassium.

Compost

In one experiment, compost (consisting of rice straw to which ammonium sulphate was added to promote decay) was applied to single

TABLE 13 — THE EFFECT OF COMPOST ON THE YIELDS OF FORTUNA RICE AT CROWLEY, LOUISIANA., 1926-43 [1]

Acre Yields In Bushels							
Year	Compost	No Treatment	Increase	Year	Compost	Treatment	Increase
1926	65.1	71.8		1933	41.4	37.1	
1927	30.7 [2]	20.0 [2]		1934	27.2	29.8	
1928	51.8	49.8		1935	32.0	29.2	
1929	49.1	46.2		1936	22.5	22.2	
1930	40.7	38.9		1937	33.7	32.0	
1931	52.0	48.7		1938	49.0	41.8	
1932	48.4	41.6		1939	40.3	34.3	
				1941	34.3	40.0	
				1942	40.3	25.4	
				1943	33.1	24.5	
7-year Average 1926-32	48.2	45.3	2.9	10-year Average 1933-43	35.4	31.6	3.8
17-year Average 1926-43					41.8	38.5	3.3

[1] Original Station Land.
[2] Poor stands.

plots at the rate of 2 tons per acre from 1926 to 1932, and at the rate of 4 tons per acre in duplicate plots from 1933 to 1942, inclusive, in comparison with unfertilized plots. The Fortuna variety was grown. The annual and average yields are given in Table 13.

The average yield of the plots treated at the rate of 2 tons per acre, for the 7-year period (1926-32) was 48.2 bushels, and for the check plots 45.3 bushels, or an increase of only 2.9 bushels per acre. For the 10-year period (1933-43), the average yield of the plots treated at the rate of 4 tons per acre was 35.4 bushels, and that of the untreated plots 31.6 bushels, an increase of 3.8 bushels per acre. The average yield for the 17-year period (1926-43) was 41.8 bushels for the treated, and 38.5 bushels for the untreated check, or an increase of 3.3 bushels per acre.

Straw With And Without Fertilizer

Six years' data (1937-43) are available for an experiment conducted to determine the effect of 3 tons of straw turned under in the fall immediately after harvesting the rice crop, with rice grown continuously and in alternate years, the land when not in rice being in stubble pasture; also, with and without 400 pounds of a complete (8-10-6) fertilizer, half applied with the straw and half with the seed. The straw alone was not included the first year. The Rexoro variety was grown, and each treatment was replicated 4 times. The annual and average yields are given in Table 14.

TABLE 14—THE EFFECT OF STRAW ALONE AND STRAW PLUS A COMPLETE FERTILIZER ON THE YIELDS OF REXORO RICE AT CROWLEY, LOUISIANA, 1937-43

Treatment	Acre Yields In Bushels							
	1937	1938	1939	1941	1942	1943	6-year Average 1937-43	Average Increase
	Alternate Cropping							
No Straw or Fertilization (ck.)	44.2	71.0	47.2	48.4	65.3	35.5	50.1	——
3 Tons of Straw	——	72.3	55.1	57.5	55.9	49.2	58.0[1]	4.5[1]
3 Tons of Straw and Fertilizer	53.9	78.2	71.8	61.8	73.4	61.0	66.7	16.6
	Continuous Cropping							
No Straw or Fertilizer (ck.)	49.1	62.9	37.9	45.2	40.7	35.1	45.2	——
3 Tons of Straw	——	63.7	48.2	47.3	45.4	42.5	49.4[1]	5.0[1]
3 Tons of Straw and Fertilizer	67.1	69.4	69.4	53.8	56.2	50.0	61.0	15.8

[1] Five-year average (1938-1943) yields and increases

The 5-year average increase in yields from the application of 3 tons of straw alone was only 4.5 bushels for the alternately cropped, and 5.0 bushels per acre for the continuously cropped plots. These differences are not statistically significant. The 6-year (1937-43) average increase in yields from the application of straw plus fertilizer was 16.6 bushels for the alternately cropped and 15.8 bushels per acre for the continuously cropped plots. These differences are statistically significant, and indicate that to get the maximum benefit from the application of straw, it is necessary to use fertilizer. The average yields of the unfertilized plots indicate that the land was relatively fertile as compared to most other areas on the Station. The results of this experiment and of the preceding experiment, in which compost was used, indicate that the plowing under of rice straw and the addition of compost improves the productivity of rice soils low in organic matter. The additional increases secured by the use of fertilizers with straw also suggest the need of applying both.

Complete Fertilizer With Three Sources Of Phosphorous

In 1937, a fertilizer experiment was begun to determine the comparative effect on rice fields of complete fertilizers with three different sources of phosphorous. This experiment was conducted with rice grown in alternate years on land that in the 4 years preceding 1937 had been devoted to improved pasture. The phosphorous, namely T. V. A. treble phosphate, T. V. A. fused phosphate, and bone meal, was applied in an 8-10-6 formula at seeding time at the rate of 400 pounds per acre. The Rexoro variety was grown from 1937-41, and Blue Rose 41 in 1942 and 1943. Each treatment was replicated 4 times. The annual and average yields are given in Table 15.

TABLE 15—THE EFFECT OF PHOSPHORUS FROM THREE DIFFERENT SOURCES ON THE YIELDS OF REXORO RICE AT CROWLEY, LOUISIANA, 1937-43

Fertilizers Used	Acre Yields In Bushels							
	1937	1938	1939	1941	1942	1943	Average	Average Increase
No. Fertilizer (ck.)	52.6	58.5	67.6	60.9	47.2	47.4	55.7	——
T. V. A. Treble Superphosphate	62.9	65.7	77.7	74.0	72.8	67.4	70.1	14.4[1]
Bone Meal	57.4	66.6	76.6	76.2	66.4	66.2	68.2	12.5[1]
T. V. A. Fused Phosphate	60.6	67.4	73.8	78.0	67.8	67.2	69.1	13.4[1]

[1] Significant at 5 percent level on basis of paired plots compared with the checks.

The three sources of phosphorous all gave marked increases in average yields. The average increase for the 6-year period (1937-43) for the T. V. A. Treble phosphate was 14.4, for T. V. A. fused phosphate 13.4, and for bone meal 12.5 bushels per acre, respectively. These increases are statistically significant, and indicate that the three sources of phosphorous were about equally effective in increasing yields. The yield of the check plots was 55.7 bushels per acre, indicating that this land was in a higher state of fertility than most other areas on the Station.

Complete Fertilizers With Six Sources Of Phosphorous Applied At Different Rates

An experiment combining sources of phosphorous and rates of application was conducted in 1939, 1941, and 1942. The phosphates were applied in an 8-10-6 formula at seeding time at the rate of 100, 200, and 300 pounds per acre, on land cropped in alternate years. The Rexoro variety was grown and each treatment was replicated 4 times. The annual and average yields are shown in Table 16.

TABLE 16 — THE EFFECT OF PHOSPHORUS FROM SIX SOURCES, APPLIED AT DIFFERENT RATES, ON THE YIELDS OF REXORO RICE AT CROWLEY, LOUISIANA, 1939-42.[1]

Fertilizers Used	Acre Yields In Bushels												Average
	1939			1941			1942			3-yr. Average (1939-42)			
	Rate of application (lbs.)												
	100	200	300	100	200	300	100	200	300	100	200	300	
No. Fertilizer (ck)	36.6	42.4	34.3	19.5	22.2	20.8	36.6	41.3	38.3	30.9	35.3	31.1	32.4
Superphosphate	41.0	51.4	48.7	24.9	27.6	28.6	37.0	36.0	41.3	34.3	38.3	39.5	37.6
Basic Slag	38.0	50.4	41.7	25.9	25.9	18.2	37.3	39.3	41.7	33.7	38.5	33.8	35.4
Bone Meal	42.5	52.4	45.4	25.6	24.2	20.8	38.0	38.0	36.6	35.3	38.2	34.3	35.9
T. V. A. Fused Phosphate	44.4	50.8	50.4	28.9	27.6	21.5	35.6	37.3	36.6	36.3	38.5	36.2	37.0
T. V A Ca-meta Phosphate	46.0	50.8	50.5	22.9	27.2	24.5	37.0	39.3	44.4	35.3	39.1	39.8	38.1
Colloidal Phosphate	45.4	53.3	41.2	27.6	29.6	30.9	39.0	38.3	45.4	37.3	44.0	39.2	40.0
Average	35.9	50.2	44.6	25.0	26.3	23.6	37.2	38.5	40.6	—	—	—	—

[1] Original Station Land

Three years is too short a period to give conclusive results, but certain trends are indicated. The average increases in yields for all sources of phosphorous were, for the 100-pound rate 4.5 bushels, for the 200-pound rate 4.1 bushels, and for the 300-pound rate 6.0 bushels per acre. For the 3 rates combined, the highest average yields were for colloidal phosphate 40.0 bushels, T. V. A. Ca-meta phosphate 38.1 bushels, and for superphosphate 37.6 bushels per acre, which indicate that each of these sources of phosphorous is satisfactory for rice, since the unfertilized plots averaged only 32.4 bushels per acre.

At the 100-pound rate of application, the highest average yields were for colloidal phosphate 37.3 bushels, or a gain of 6.4 bushels as compared with the unfertilized check, for T. V. A. fused phosphate 36.3, and for T. V. A. Ca-meta phosphate 35.3 bushels per acre. At the 200-pound rate, the highest average yields were for colloidal phosphate 44.0 bushels or a gain of 8.7 bushels, for T. V. A. Ca-meta phosphate 39.1, and for T. V. A. fused phosphate and basic slag 38.5 bushels per acre. At the 300-pound rate, the highest average yields were for T. V. A. fused phosphate 39.8 bushels or a gain of 8.1 bushels, for superphosphate 39.5 bushels, and colloidal phosphate 39.2 bushels per acre. Colloidal phosphate was the best at two rates and as good as the best at the third rate. The increases in yield even for the higher rates of application are somewhat less than were secured in the preceding experiment because the land was in a lower state of productivity. It has been the general experience at the Crowley Station that the best response to fertilizer is secured on land above average in productivity.

Residual Effect of Phosphorous

Beginning in 1933, duplicate plots were fertilized with a 2-25-3 formula at the rate of 1600 pounds per acre each year until 1937, after which no fertilizer was applied. Rice was grown each year up to and including 1942, the variety Fortuna being used. The annual and average yields, together with those of the check plots, are given in Table 17.

TABLE 17 — THE RESIDUAL EFFECT OF PHOSPHATE FERTILIZER ON YIELDS OF FORTUNA RICE (1933-42), AT CROWLEY, LOUISIANA.[1]

Year	Yield Per Acre In Bushels	
	Fertilized	Not Fertilized
1933	60.0	47.3
1935	30.5	23.9
1936	24.2	33.7
1937	37.0	42.4
1938	40.3	47.7
1939	25.6	39.0
1941	26.9	28.9
1942	35.6	22.9
Average	35.0	35.7

[1] Original Station Land.

The average yield of the fertilized plots for the entire period was 35 bushels and of the check plots, 35.7 bushels per acre. The average yield for the 4 years (1933-37) for the fertilized plots was 37.9, and for the check plots 36.8 bushels per acre, and 32.1 and 34.6, respectively, for the following 4 years. These results indicate that an unusually heavy pplication of a phosphate fertilizer on continuously cropped land had no appreciable effect on the average yields during the years that it was applied, nor during the succeeding 4-year period. In this experiment, the amounts of nitrogen and potassium applied in the earlier years were probably too small to have an appreciable immediate or residual effect on yields.

Ammonium Sulphate and Ammophos

An experiment to determine the effect of ammonium sulphate and ammophos (8-10-0) on the yields of rice grown on continuously cropped land was started in 1937. Each fertilizer was applied at the rate of 400 pounds per acre with the seed, on the water 3 weeks after irrigation, and on the water 8 weeks after irrigation. The Rexoro variety was grown, and the irrigation water was applied 20 days after seedling emergence. The plots were replicated 4 times. The annual and average yields are shown in Table 18.

TABLE 18 — THE EFFECT OF AMMONIUM SULPHATE AND AMMOPHOS ON THE YIELDS OF REXORO RICE AT CROWLEY, LOUISIANA, (1937-42).

Fertilizer And Time Of Application	Acre Yields In Bushels						
	1937	1938	1939	1941	1942	Average	Average Increase or Decrease
No fertilizer (check)	37.1	42.4	39.1	37.5	30.4	37.3	—
Ammonium Sulphate With Seed	35.0	38.9	30.0	39.5	35.1	35.7	-1.6
Ammonium Sulphate 3 Weeks After Irrigation	34.6	41.8	37.1	39.1	31.7	36.9	-0.4
Ammonium Sulphate 8 Weeks After Irrigation	43.6	46.2	34.9	40.7	32.5	39.6	2.3
Ammophos With Seed	39.4	45.6	38.7	28.8	38.7	38.3	1.0
Ammophos 3 Weeks After Irrigation	43.3	42.8	37.9	30.8	33.9	37.7	0.4
Ammophos 8 Weeks After Irrigation	36.4	51.0	48.2	35.7	41.5	42.6	5.3

Applications of ammonium sulphate at seeding and 3 weeks after irrigation gave slightly lower, and ammophos applied at the same time gave slightly higher average yields than the check plots. In neither case were the differences significant. Each fertilizer when applied 8 weeks after irrigation, however, gave small increases in average yields, though the increases were probably too small to cover the cost of the fertilizers and their application under normal conditions. These results suggest that the use of ammonium sulphate or ammophos alone on land cropped each year is not likely to be profitable, but this is not necessarily so on land cropped in alternate years, as shown in the following experiment.

Complete and Incomplete Fertilizers

A fertilizer experiment in which various formulas including complete and incomplete fertilizers were compared was started in 1939. Each fertilizer was applied with the seed on land cropped in alternate years at the rate of 200 pounds per acre. The Rexoro variety was grown and each treatment was replicated 4 times. The annual and 4 year (1939-43) average yields are shown in Table 19.

TABLE 19 — THE EFFECT OF COMPLETE AND INCOMPLETE FERTILIZERS ON THE YIELDS OF REXORO RICE AT CROWLEY, LOUISIANA, 1939-43.[1]

Fertilizers Used	Acre Yields In Bushels					
	1939	1941	1942	1943	4-year Average 1939-43	Average Increase
0-10-6	37.6	22.5	33.6	22.8	29.2	0.4
4-10-6	45.7	30.6	38.6	27.6	35.6	6.8
8-10-6	46.4	33.3	39.3	29.9	37.2	8.4
12-10-6	41.0	30.9	42.7	30.6	36.3	7.5
8-0-0	42.7	26.2	38.3	37.3	36.1	7.3
None (ck)	32.6	19.5	41.3	24.9	29.6	—
8-0-6	37.6	25.2	35.6	34.6	33.3	4.5
8-5-6	42.4	25.9	44.7	26.6	34.9	6.1
8-15-6	42.4	23.2	39.0	25.2	32.5	3.7
0-10-0	36.6	25.2	36.6	23.2	30.4	1.6
None (ck)	33.9	22.9	34.0	23.2	28.5	—
8-10-0	37.0	31.9	43.7	21.8	33.6	4.8
8-10-3	40.7	32.6	40.0	21.2	33.6	4.8
8-10-9	44.7	30.2	40.7	20.5	24.5	5.7
0-0-9	34.6	25.2	35.6	16.1	27.9	-0.9
None (ck)	34.0	21.8	37.0	19.8	28.2	—

[1] Original Station Land.

The highest 4-year average yields were 37.2 bushels with the 8-10-6, 36.3 bushels with the 12-10-6, and 36.1 bushels per acre from the 8-0-0 formula. In the order listed, the increases over the check plots were 8.4 bushels, 7.5 bushels, and 7.3 bushels per acre, respectively. The increases for the 0-10-6, 0-10-0, and 0-0-9 formulas were very small. These results, as for others discussed, indicate (1) that a complete fertilizer is more effective in increasing yields than either of the three elements applied alone, and (2) that of the complete fertilizers tested, the 8-10-6 is best, closely followed by the 12-10-6, 8-5-6, and 8-10-9 formulas.

Rates of Application of Complete and Incomplete Fertilizers

In an experiment conducted 4 years, complete and incomplete fertilizers were applied on the water 8 weeks after the land was submerged, at the rate of 100, 200, and 300 pounds per acre on land cropped in alternate years. The Rexoro variety was grown, and each treatment was replicated 4 times. The annual and average yields are given in Table 20.

TABLE 20 — THE EFFECT OF COMPLETE AND INCOMPLETE FERTILIZERS APPLIED AT DIFFERENT RATES ON THE YIELDS OF REXORO AT CROWLEY, LOUISIANA, 1939-43.

Rates of application and fertilizers used.	Acre Yields In Bushels					
	1939	1941	1942	1943	4-year Average 1939-43	Average Increase
100 pounds per acre:						
8-0-0	56.8	35.2	44.1	49.3	46.4	0.3
0-10-0	56.1	33.0	49.1	46.5	46.2	0.1
8-10-0	54.9	39.3	49.1	47.1	47.6	1.5
8-10-6	61.7	42.4	56.8	50.2	52.8	6.7
Check	56.4	35.2	47.0	45.8	46.1	—
200 pounds per acre:						
8-0-0	57.1	35.2	44.3	52.4	47.3	0.0
0-10-0	57.7	34.0	49.6	53.6	48.7	1.4
8-10-0	68.6	36.2	57.4	57.7	55.0	7.7
8-10-6	65.5	45.5	62.0	57.1	57.5	10.2
Check	59.9	35.2	44.0	50.2	47.3	—
300 pounds per acre:						
8-0-0	58.0	31.5	50.8	53.6	48.5	0.6
0-10-0	64.9	32.7	57.7	54.9	52.5	4.6
8-10-0	65.8	29.0	63.6	52.7	52.8	4.9
8-10-6	69.5	39.0	69.5	53.6	57.9	10.0
Check	56.8	36.5	47.4	51.1	47.9	—

The largest increases were secured from the 200- and 300-pound rates of application and with complete fertilizers and those containing both nitrogen and phosphorous. The complete fertilizer (8-10-6) applied at the 200-pound rate was the most economical. Nitrogen alone

(8-0-0), and phosphorous alone (0-10-0), failed to materially increase yields, but nitrogen and phosphorous together (8-10-0) gave an increase of 7.7 bushels per acre at the 200-pound rate.

This experiment and the preceding one are closely related since they deal primarily with a comparison of different fertilizer formulas. The results agree in suggesting that material increases in yield should not be expected except with a complete fertilizer or at least one that contains both nitrogen and phosphorous. Phosphorous alone, which in general seems to be needed even more than nitrogen, and likewise phosphorous combined with nitrogen gave at the higher rates relatively small increases in yield. The land, however, was not in a high state of fertility in the first-mentioned experiment, as shown by the relatively low yields of the check plots. The results with rates of application suggest that at least 200 pounds per acre should be applied.

In a somewhat similar experiment, Rexoro was grown on land cropped in alternate years to which 400 pounds of a complete fertilizer (8-10-6) was applied (1) with the seed, and (2) 200 pounds with the seed plus 200 pounds on the water 8 weeks after submergence, were compared. The data are not tabulated, but the 4-year (1939-43) average yield of the unfertilized check plots was 54.3 bushels, for the 400-pound rate applied with the seed 56.5, and for the spilt application 63.4 bushels per acre. The average increase for the application with the seed was 2.2 bushels, and when half of the fertilizer was applied with the seed and the other half on the water 8 weeks after submergence 9.1 bushels per acre. The spilt application was therefore much more effective.

The results of recent fertilizer experiments in other rice producing States are briefly reviewed below.

Nelson (8), in Arkansas, reported significant increases in the average yields of rice from the application of 500 pounds per acre of (1) a complete (4-8-4) fertilizer 6 or 8 weeks after seeding; (2) ammophos (4-8-0), and ammophos plus sulphate of potash (4-5-4) 6 weeks after seeding; and (3) ammonium sulphate (4-0-0) 4 weeks before and 10 weeks after seeding. The residual effect of fertilizers used on preceding crops did not result in a marked increase in the yield of the succeeding rice crop.

Wyche (10), at the Rice Experiment Station, Beaumont, Tex., reported increased yields from the application of sulphate of ammonia alone. Phosphoric acid alone did not increase yields, but a combination of sulphate of ammonia and phosphoric acid was superior to nitrogen alone during the latter period of the test. He found that the response of soils to the application of fertilizers varied in different localities. In Liberty County, nitrogen alone gave practically no increase in yields, whereas, phosphoric acid increased yields and a combination of nitrogen and phosphoric acid increased yields materially. In Orange County, phosphoric acid alone gave a marked increase in yields, but nitrogen alone did not increase yields. At Beaumont, sulphate of ammonia alone and a combination of sulphate or ammonia and phosphoric acid, when drilled in with the seed, gave a larger yield of rice than when broadcast on the surface of the soil. As sources of phosphorus, bone meal and superphosphate were of essentially the same value. The minor plant food elements, iron, manganese, copper, zinc, and boron, did not appear to be deficient on the soils used. On the principal rice soils of the Texas area, a fertilizer containing 20 pounds each of nitrogen and phosphoric acid, in the form of sulphate of ammonia and superphosphate, applied with the seed when drilled, is recommended.

Davis and Jones (4), in California, reported marked increases in the average yields of rice from applications at seeding time of 100, 150, and 200 pounds of ammonium sulphate per acre. With the Caloro variety, the 150-pound rate gave the largest increase in yield and net return per acre; whereas, with the Colusa variety, the 200-pound rate was most profitable. The application of ammonium sulphate at seeding time was more effective in increasing yields than when applied during the tillering or heading stages of growth. During a 5-year (1932-36) period, rice was grown on land fertilized with ammonium sulphate, ammophos, leunasalpeter, urea, ammosphosko, leunaphos, calurea, and cyanamide, at rates that added 21, 31.5, and 42 pounds of nitrogen per acre, respectively. At each rate of application, ammonium sulphate was most profitable. The application of superphosphate and potassium sulphate alone and in combination failed to increase yields materially.

Rice is of course grown on various soil types and under different environmental conditions, and for this reason, it is not unusual to find marked variability in the response of the crop to fertilizers. On some soils, nitrogeneous fertilizers alone give marked increases in yields, on others the crop responds better to phosphorus than to nitrogen, and often fertilizers containing both nitrogen and phosphorus are more effective in increasing yields than either element applied alone. In general, most rice soils appear to contain sufficient available potash to produce relatively high yields.

PERMANENT-PASTURE EXPERIMENT

The general practice in rice farming is, as has been stated, to grow a crop, then use the land for cattle pasture the following year. The farm is usually divided into two main parts, one sown to rice and the other grazed in alternate years. The cattle are used mainly to destroy weeds on land intended for rice the following year. The practice has resulted in the use of low-grade cattle that have received little attention, and often little or no profit has been obtained directly from the cattle. During the summer and fall months, there usually is sufficient growth on the land to keep cattle in fair condition, but this is not true in dry years. The principal growth for summer grazing is volunteer red rice, an objectionable variety, and the most troublesome weed in rice fields.

Rice farmers are coming to realize it is possible to make cattle raising as an adjunct to rice growing a more profitable enterprise, and there is need for information as to how this can best be accomplished.

One of the problems is lack of feed during the winter and spring, since there is very little growth of any kind on land which grew rice the previous year. Land grazed in the summer is usually plowed in the fall, in preparation for the next rice crop, and this destroys most of the vegetation. While rice straw is abundant and has some food value, it alone will not satisfactorily sustain cattle. This is emphasized by the poor condition of the cattle and the large number that die, especially in sever winters.

An experiment accordingly was undertaken in 1932 to determine what permanent pasture crops can be grown on rice lands in southwestern Louisiana, and to secure information relative to the best treatment of such pastures. These consisted of comparisons of various grasses and clovers and of fertilizer treatments.

The experiment was conducted in 14 large single plots, ranging in size from about 1/7 to 1/4 of an acre, three of which were fertilized and limed, five were fertilized only, three received lime only, and three received neither fertilizer nor lime. The fertilizers were applied at the time the land was prepared for seeding in January, 1932, at the rate of 600 pounds of 16 percent superphosphate and 200 pounds of muriate of potash per acre. The following spring, ground limestone was applied in one application at the rate of 2,000 pounds per acre to plots receiving lime. No fertilizer or lime was again applied until April 15, 1938, when the fertilized plots received 1,000 pounds of a 5-15-5 formula, and on February 10, 1939, the limed plots received 1,000 pounds of lime per acre.

Four plots were seeded to a mixture of Bermuda grass, white clover, and common lespedeza; four to a mixture of Bermuda grass, Dallis grass, lespedeza, Persian clover, and white clover; and the remaining six plots were not seeded. All plots were prepared in the same manner, except those not seeded were left for a natural growth to develop. The land had in the past several years been in various crops including rice, soybeans, and grass. Most of the growth during the first two years consisted of native grasses.

On December 15, 1937, all plots except one (No. 8) that had not been seeded were disked and treated as in the beginning, except that no Persian clover was seeded.

The plots were mowed several times during the first growing season (1932), but no attempt was made to estimate yields as the plants had not become well established. In subsequent years, the plots were not grazed but were mowed once each month during the growing season. The hay was removed from the mowed pastures. Mowing in some years began as early as the latter part of March, and continued until the first week in October. The yields each year were estimated by clipping five 5-foot square areas from each plot. Aliquot weights of green matter from each plot were cured, and from this the yield per acre in cured hay was estimated. The yields for 1940 were not complete on account of a flood.

Very good stands of lespedeza and Bermuda grass were secured. The stand of Dallis grass was fair. In the succeeding years (1932-37), however, there was a gradual change in the vegetation. Very little white clover was noted after 1932, and Persian clover had practically disappeared by 1934. Lespedeza began to decrease after 1934, but remained scattered throughout all plots until the fall of 1937. By 1937, very little Dallis or Bermuda grass was noted. Up to this time, these grasses had remained green each year for a longer period than other kinds of vegetation. Carpet began to increase in 1936, and by the fall of 1937 it was the predominating grass in all plots.

By the end of the third year, the plots not seeded contained much the same growth as those that had been seeded. This was due to the fact that carpet grass, Bermuda grass, and common lespedeza produce viable seed that became scattered over the adjoining plots. The seed is probably distributed by wind and water from heavy rains. In the early spring of some years, hop clover was abundant in all plots and greatly increased the yield of hay.

The stimulating effect of lime on clovers and grasses in the early part of the season was noticeable in most years. The effect was most striking on white clover, a few plants of which were found in limed plots as late as 1937. The poorest growth of lespedeza, however, was on the limed plots.

In the period from 1938 to 1943, inclusive, that is after the original treatments had been repeated in 1937, the behavior of the different kinds of plants and the effect of lime were practically the same as indicated for the period from 1932 to 1937, inclusive, except that carpet grass became more general throughout the plots by the end of the second season.

The plot left undisturbed during the eleven years had a stand throughout most of that time and up to the fall of 1943, of a rather uniform mixture of carpet grass and common lespedeza.

The annual and 10-year average yields of cured hay are given in Table 21.

TABLE 21 — YIELDS OF HAY, IN TONS PER ACRE, FROM PERMANENT PASTURES ESTABLISHED AND TREATED IN VARIOUS WAYS, CROWLEY, LOUISIANA, (1933-43)

Year	Bermuda Grass, White Clover, and common lespedeza				Bermuda Grass, Dallis Grass, common lespedeza, Persian Clover, and White Clover				Native Grass				Native Grass	
	Limed		Not Limed		Limed		Not Limed		Limed		Not Limed		Sod Broken as Necessary Not Limed Fertilized	Sod Not Broken Not Limed Fertilized
	F[1]	NF[2]	F	NF	F	NF	F	NF	F	NF	F	NF		
1933	5.74	4.14	5.35	4.27	5.18	4.16	4.30	3.71	3.34	2.64	3.13	3.20	3.97	3.65
1934	5.26	3.78	3.89	3.46	5.08	2.07	3.93	2.79	4.08	3.45	3.67	2.82	2.90	2.94
1935	4.28	3.53	3.25	2.70	3.59	3.20	2.81	2.90	3.25	3.19	3.64	3.40	2.39	2.63
1936	1.92	2.00	1.82	1.77	1.58	1.60	1.56	1.44	1.62	2.00	1.81	1.67	1.28	1.89
1937	2.52	2.22	2.59	1.76	2.42	1.50	2.09	1.28	2.07	1.50	2.35	1.48	1.38	1.27
1938	2.41	2.10	1.77	1.82	1.94	1.71	1.51	1.53	1.90	1.62	2.09	1.34	1.38	1.19
1939	1.79	1.90	1.87	1.73	2.07	1.52	1.93	1.36	1.61	1.75	1.60	1.57	1.29	1.27
1941	3.03	3.22	2.49	1.97	2.78	3.14	2.89	2.73	3.11	3.17	2.87	1.86	1.68	1.60
1942	3.11	2.88	2.94	2.41	2.70	2.86	2.56	2.10	2.73	2.39	2.78	2.06	1.83	1.77
1943	1.94	1.96	1.96	2.03	1.89	2.04	2.04	1.55	1.80	1.52	1.84	1.74	1.62	1.77
Av.	3.05	2.62	2.64	2.23	2.77	2.22	2.44	2.02	2.41	2.20	2.43	2.03	1.84	1.86

[1] F—Fertilized

[2] NF—Not Fertilized.

The highest 10-year average yield (3.05 tons per acre) was from the plot seeded to Bermuda grass, white clover, and common lespedeza, limed and fertilized. The lowest average yield (1.84 tons per acre) was from native grasses with the sod broken in the fifth year and fertilized but not limed. Lime increased the average yields of all plots 0.26, fertilizer 0.41, and both lime and fertilizer 0.65 tons of cured hay per acre. There was practically no difference in the average yields of the two plots of native grasses, one fertilized on sod broken and reprepared in the fifth year and the other fertilized but the sod not broken.

In this experiment, the monthly cutting of the clovers prevented the setting of appreciable quantities of seed which would normally occur if the plots were grazed. Since Persian clover is a winter annual and white clover principally behaves as a winter annual in the southern States, adequate quantities of seed of each species are needed each fall to establish volunteer stands. A thick growth of grass in the fall also prevents the establishment of stands of clovers. Many rice growers throughout the Gulf Coast region are successfuly growing winter annual clovers under grazing conditions with adequate mineral fertilization.

DISCUSSION

In the preceding experiments, it has been shown that the yield of rice is materially affected by the variety grown, by the method of irrigation used, by the rotation system followed, and by the kind amount and time of application of fertilizers.

Of the varieties tested, the early-maturing Zenith and Early Prolific; the midseason Acadia, Blue Rose, Nira, and Fortuna; and Rexoro, which matures late, are best adapted for growing in Louisiana. These include short-, medium- and long-grain varieties that differ materially in market value. These varieties also react differently when sown from early to late in the spring, and this makes it possible for growers to choose varieties for seeding on successive dates so that the harvest can be extended over a long period and thus use to best advantage the harvesting equipment and labor available.

Grasses and aquatic weeds must be controlled in order to produce satisfactory yields of rice. Fortunately, grasses usually can be controlled by thorough seedbed preparation and by timely irrigation after the rice seedlings come up. On land submerged in from 10 to 20 days after the seedlings emerge, the growth of grasses is checked, and hence, they cause little or no reduction in yields. On land free of grass, however, submergence can be safely delayed until 30 to 40 days after the seedlings emerge. Grasses also can be controlled by seeding in the water, but the stands and yields obtained by this method were less satisfactory than for properly irrigated drilled rice.

Aquatic weeds are not so troublesome on well prepared seedbeds having good stands of rice. However, in thin stands, these weeds often appear soon after the land is submerged and in low areas with deep water they reduce yields.

Soils of the warm humid sections of the United States often are deficient in organic matter, and this is especially true in the rice area. Therefore, rotations that increase or at least maintain the humus content of the soil should be used. In the present studies, the highest average yields of rice were obtained when the crop was grown in rotations with stubble and improved pastures. Yields were slightly lower following corn and soybeans, and these crops were of less value than pasture. Cotton is not a satisfactory crop for growing in rotation with rice, for it must be dusted with calcium arsenate to control boll weevil and the residual effect of the calcium arsenate materially reduces rice yields. Growing rice in alternate years, or once in three years, on stubble pasture, and following improved pastures gave the best results. To establish improved pastures requires a relatively long time and the longer period in pasture was beneficial to the soil and the succeeding rice crops.

In the fertilizer experiments, the average yields of rice were increased materially by the application of a complete fertilizer at seeding time and 8 weeks after the land was submerged. The largest increases in yields, from the application of fertilizers, were obtained on relatively fertile land, such as improved pasture and land on which straw had been turned under. On less fertile land, the increases were smaller, which indicates that it is necessary to maintain the organic matter in the soil in order to obtain maximum benefits from the use of fertilizers. The source of phosphorous, in a complete fertilizer, was of less importance than the formula used. The largest and most consistent increases in yield were obtained with the 8-10-6 formula.

This fertilizer, applied at seeding time at the rate of 400 pounds per acre, gave the largest increases in yield, but applications at seeding time and 8 weeks after irrigation at the rate of 100, 200, and 300 pounds per acre, also materially increased yields. On weedy land, complete fertilizers applied at seeding time often stimulate the growth of grasses that compete with and may crowd out the rice seedlings. Furthermore, the nitrogen content of fertilizers applied at seeding time, unless absorbed by the soil, may be lost before the seedlings are large enough to utilize it. Thus, fertilizers may, under such conditions, actually reduce yields. On grassy land, therefore, best results often are obtained by applying fertilizers from 4 to 8 weeks after the land has been submerged.

The results presented in the preceding pages indicate that by using well adapted varieties, good cultural irrigation and rotation practices, and suitable fertilizers, the average yield of rice in Louisiana can be increased materially.

SUMMARY

In Louisiana, rice is the second most important cash crop, ranking next to cotton. The principal area of production is in the southwestern part of the State, in Acadia, Vermilion, Jefferson Davis, and Calcasieu parishes. Relatively level clay soils, an ample supply of fresh irrigation water, and a subtropical climate each contribute to the success of rice culture in this area.

Yields of varietal experiments show that Zenith and Early Prolific in the early group, Blue Rose, Fortuna, Nira, and Acadia in the midseason group, and Rexoro in the late group, are well adapted for growing in Louisiana.

In date-of-seeding experiments, the highest average yields of Fortuna, Rexoro, Blue Rose, and Caloro were obtained from seeding about April 1, and for Early Prolific and Nira, from seeding May 1 and May 15, respectively. The number of days required from seeding to maturity, for each variety, decreased as the date of seeding was delayed. Thus, for a difference of 76 days in the time of seeding (March 17 and June 1), there was a spread in dates of maturity of about 50 days for Rexoro, Nira, Fortuna, and Early Prolific, but only about 20 days for Blue Rose and Caloro. This difference in the response of rice varieties when sown on different dates should be borne in mind by growers who plan on seeding so as to distribute the harvest over a relatively long period, and by those who are forced to seed late in the spring.

The highest average yields of the Caloro, Blue Rose, Rexoro, and Fortuna varieties, when sown broadcast in the water, were from seeding on April 1.

In a date-of-submergence experiment, the highest average yields for each variety were obtained on land submerged 20 days after the seedlings had emerged. In a discontinuous and continuous submergence experiment, early (i. e. 10 days after seedling emergence) continuous submergence of the land gave higher average yields than intermittent drying of the land followed by continuous submergence.

Holding water on rice stubble or uncropped land during the fall, winter, and summer, or after late fall plowing until March 1, had no beneficial nor detrimental effect on the average yields of rice.

In 2-year rotations, the highest average yield of rice was 49.7 bushels per acre, following Italian ryegrass, and following clovers on stubble pasture. A slightly lower average yield (48.1 bushels per acre) was obtained following cultivated fallow and following soybeans plus bur clover sown in the fall. The lowest average yield (36.3 bushels) was following cotton dusted with calcium arsenate. The yields of cotton and of soybeans in these experiments were too low to be profitable. In another experiment, the average yield following cotton dusted with calcium arsenate was 31.9 bushels, and after cotton not dusted 45.1 bushels, a decrease of 13.2 bushels, due apparently to the residual effect of calcium arsenate.

In a 3-year rotation of cotton, soybeans, and rice, the average yields of cotton and soybeans were too low to be profitable, and the average yield of rice was 45.9 bushels per acre, or somewhat less than that from the better 2-year rotation.

In 4-year rotations consisting of two successive rice crops following 2 years in cotton fertilized and not fertilized, and in stubble pasture fertilized and not fertilized, the yields of rice were not increased by fertilizing, but the rice after stubble pasture yielded 7.4 bushels more than that following cotton. In other words, fertilizer applied to cotton or on stubble pasture land did not benefit the succeeding rice crop. The results are in accord with those of other rotation experiments, however, in indicating a material gain from rotating rice with pasture rather than with cotton.

In 10-year rotations of 5 successive rice crops following 5 years each in (1) cotton, (2) native pasture, (3) corn plus soybeans, and (4) improved pasture, the 4-year average yield of rice following improved pasture was 48.7 bushels; after native pasture, 47.1 bushels; after corn plus soybeans, 45.6 bushels; and following dusted cotton, 32.1 bushels per acre.

On land cropped continuously to rice for 49 years, the 5-year average yields for the last 30-year period ranged from 24.5 to 32 bushels per acre. The fluctuations in the 5-year average yields appear to be due to variations in climatic conditions rather than to depletion of the soil fertility.

In fertilizer experiments, the application of compost at the rate of 2 and 4 tons per acre gave an average increase in yield, for a 17-year period, of 3.3 bushels per acre.

The plowing under of 3 tons of straw per acre with and without the application of 400 pounds of an 8-10-6 fertilizer, half applied with the straw and half with the seed, gave for straw alone an average increase of 4.5 bushels on alternately cropped, and 5.0 bushels on continuously cropped land, and for straw plus fertilizer 16.6 bushels on alternately cropped and 15.8 bushels on continuously cropped land.

In an experiment conducted in conjunction with a rotation in which rice was grown in alternate years on improved pasture land, the average increase in yield from an 8-10-6 formula applied at seeding time at the rate of 400 pounds per acre was for T. V. A. treble phosphate 14.4 bushels, for T. V. A. fused phosphate 13.4 bushels, and for bone meal 12.5 bushels per acre.

On continuously cropped land, ammonium sulphate and ammophos fertilizer, when applied at the rate of 400 pounds per acre with the seed and on the water 3 weeks after the land was submerged, gave no appreciable increase in yields, but when applied on the water 8 weeks after submergence, ammonium sulphate gave an average increase of 2.3, and ammophos 5.3 bushels per acre.

The application at seeding time of an 8-10-6 fertilizer on alternately cropped land, with phosphates from various sources, at the rate of 100, 200, and 300 pounds per acre, gave average increases for all sources of phosphate of 4.5, 4.1, and 6.0 bushels per acre from the 100, 200, and 300 pound rates. Fertilizers differing in formula were applied on the water 8 weeks after submergence at the rate of 100, 200, and 300 pounds per acre and for each rate of application the highest average yield was from the 8-10-6 formula. The average increase in yield from the application of 400 pounds of an 8-10-6 fertilizer with the seed was 2.2 bushels, and when half was applied with the seed and half on the water 8 weeks after the land was submerged, 9.1 bushels per acre. Various fertilizer combinations were applied with the seed at the rate of 200 pounds per acre, and the highest average yield was from the 8-10-6 formula.

In southwestern Louisiana, the general practice is to grow a rice crop, then use the land for cattle pasture for one or two years. Rice is the main cash crop with beef cattle a supplementary source of income. In permanent-pasture studies, the highest average yields of cured hay were from seeded improved pastures limed and fertilized.

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POULTRY AND EGG PRICES AT NEW ORLEANS

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POULTRY AND EGG PRICES AT NEW ORLEANS

By J. M. BAKER

INTRODUCTION

New Orleans with its population of about one half million people is naturally a large consumer of poultry products. Its location makes it an important market for farm products of Louisiana and adjacent territory. No information is available to indicate the total annual consumption of poultry and eggs in this city, but it is known that in addition to the receipts from Louisiana large quantities of these products are received from other states. In the large trade area of New Orleans no doubt there are producers, dealers, agricultural workers and others who would like to have any additional information that would assist them in disposing of their products to the best advantage at this market. This report on poultry and egg prices at New Orleans is designed to render such a service.

The period covered by the material submitted is for the years 1931 to 1943. The objectives are: (1) to define the different kinds and classes of products, (2) to present the monthly and yearly prices of poultry and eggs with their seasonal and year to year variations, and (3) to explain the causes of seasonal changes in prices.

The data from which most of the prices were calculated were obtained from daily quotations in the Times-Picayune, a daily newspaper published in New Orleans. The prices for the last half of 1943 were provided by the New Orleans Office of Price Administration. The monthly prices were procured by averaging the daily quotations.

PRICES OF CHICKENS

Chickens at the New Orleans wholesale markets are divided into five different classes. In order of their importance in volume as registered at the Board of Health inspection station they are: hens, springs, roosters, broilers and capons. The amount of these different classes of poultry checked by the inspection station in 1940 is shown in Table I. Although this table gives only a part of the total receipts of chickens at New Orleans, it will serve to indicate the seasonal changes in receipts of the different classes and help to explain some of the variations in prices.

Acknowledgments are made to the wholesale produce dealers of New Orleans, Dr. C. W. Upp of L. S. U. Agricultural Experiment Station, and Mr. Clyde Ingram, Poultry Specialist, Agricultural Extension Service, for cooperation in the interpretation of the price data.

TABLE 1. AMOUNT OF CHICKENS RECORDED AT THE BOARD OF HEALTH INSPECTION STATION, NEW ORLEANS, BY CLASSES AND BY QUARTERS OF THE YEAR 1940

Class	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Year
			Pounds		
Hens	934,458	1,125,454	1,009,325	1,045,088	4,114,325
Springs	498,747	645,387	859,359	554,011	2,557,504
Roosters	24,166	39,606	30,119	32,731	126,622
Broilers	1,275	0	1,645	6,000	8,920
Capons	278	0	0	0	278
Mixed*	105,375	1,623	127,425	206,775	441,198
Total	1,564,299	1,812,070	2,027,873	1,844,605	7,248,847
			Per Cent		
Hens	22.7	27.4	24.5	25.4	100.0
Springs	19.5	25.2	33.6	21.7	100.0
Roosters	19.1	31.3	23.8	25.8	100.0
Broilers	14.3	0.0	18.4	67.3	100.0
Capons	100.0	0.0	0.0	0.0	100.0
Mixed*	23.9	0.4	28.9	46.9	100.0
Per cent of Yr.	21.6	25.0	28.0	25.4	100.0

*No record of classes in mixed lots.

Hens

All female chickens when one year old and over, or have begun to lay, are classed as hens. This class of chickens in 1940, according to Table I, constituted 57 per cent of the total receipts of chickens at New Orleans. The highest receipts of the year were in the second quarter, April, May, and June, at an average of 27.4 per cent of the total yearly receipts. The wholesale prices of hens at New Orleans, as calculated from quotations in the Times-Picayune for the years 1931 to 1943 are shown in Table 2.

TABLE 2. PRICES OF HENS AS QUOTED FOR WHOLESALE
MARKETS AT NEW ORLEANS, 1931-1943
(CENTS A POUND)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1931	19.4	17.8	19.3	21.1	19.3	18.8	18.1	18.8	18.9	18.9	18.1	17.9	18.8
1932	17.2	15.6	15.8	15.0	14.2	13.3	12.7	13.2	14.6	13.5	12.8	12.1	14.2
1933	11.8	11.7	11.3	11.5	11.2	10.9	10.3	10.8	12.1	12.0	11.2	11.0	11.3
1934	12.4	12.5	13.0	13.5	13.6	13.0	12.0	12.6	15.0	14.2	13.9	13.4	13.3
1935	14.8	15.1	16.5	17.4	17.4	17.0	14.5	16.1	18.3	18.9	18.4	17.4	16.8
1936	19.2	18.9	18.1	18.9	17.8	16.9	16.7	16.3	17.4	17.0	14.9	14.4	17.2
1937	15.8	14.6	16.1	16.4	15.3	15.1	15.3	17.6	19.5	19.8	17.8	16.4	16.6
1938	17.3	17.3	17.5	18.1	17.4	16.4	15.3	16.0	16.9	17.0	15.9	14.4	16.7
1939	15.8	15.0	15.8	15.9	14.8	13.9	13.1	13.5	15.7	14.6	13.5	12.5	14.4
1940	13.8	13.9	14.5	14.5	15.0	13.3	13.3	14.1	15.4	15.5	14.9	13.9	14.3
1941	15.1	15.9	16.8	18.1	18.7	17.5	18.6	19.1	19.3	19.7	18.2	17.6	17.8
1942	20.5	20.9	21.8	22.6	21.8	20.2	19.6	21.3	23.9	24.3	24.1	24.7	22.1
1943	27.8	28.4	30.6	31.8	27.0	27.4	27.4	27.4	27.4	27.4	27.4	27.4	28.1
Avg.	17.0	16.7	17.4	18.1	17.2	16.4	15.9	16.6	17.9	17.9	17.0	16.4	17.0

The prices of hens reached the highest monthly average for the 13-year period in April at 18.1 cents a pound (Table 2). The lowest monthly average price was in July at 15.9 cents a pound. The better prices from January to May are due to producers holding back hens during the main laying season. The low prices in the summer may be attributed to: (1) increased supply of hens at the market; (2) high percentage of poor quality hens, or culls; and (3) a good supply of young chickens. The advance in price during September and October is the result of light receipts. Laying hens and pullets are kept in the flocks because of the increase in prices of eggs. In November and December the prices of hens decline with the competition of large supplies of turkeys, rabbits and game in season.

The breed of hens affects materially their market value. Leghorn hens, for example, sell alive at one to three cents a pound below the prices of the heavier breeds. This is merely a consumer preference as little, if any, difference is noticed after the hens are dressed.

Springs and Broilers

Springs are termed "young chickens" in Table 3, and are described as chickens about one year old, or under, weighing 2.5 to 4.0 pounds. Broilers are young chickens weighing 2.5 pounds or less. Springs accounted for about 35 per cent of the chickens received at New Orleans in 1940. Broilers comprised about one per cent of the receipts.

The price of springs averaged for the 13-year period, 1931-1943, about 3 cents a pound above the price of hens, and about 2 cents a pound below the price of broilers. The steady increase in the average price of springs from 18.6 cents a pound in January to 26.3 cents a pound in April is attributed to scarcity in the supply at the market of this class of chickens and a decline in the quantity of fall and winter turkeys. The low summer prices may be charged to increase in supply. The price increase in September, which is due to decrease in supply, is checked in October, November, and December because of the usual and seasonal quantity of turkeys and rabbits offered for sale.

Breeds affect the price of young chickens also. Leghorn broilers, on the average, are quoted alive at one to three cents a pound below the prices of the heavier breeds. Barred and White Plymouth Rocks are the breeds of young chickens most in demand at the New Orleans wholesale markets.

Roosters and Capons

Roosters average little less than two per cent of the chicken receipts at New Orleans. The receipts of capons are negligible. Though the quotations on roosters were too irregular to tabulate, the price for the period appeared to be about 5 cents a pound below the price of hens. The few quotations on the price of capons were 20 cents a pound, which was ridiculously low.

TABLE 3. PRICES OF YOUNG CHICKENS AS QUOTED FOR WHOLESALE MARKETS AT NEW ORLEANS, 1931-1943
(CENTS A POUND)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1931	20.4	29.8	33.7	36.2	31.6	27.7	25.0	21.6	18.9	18.9	18.2	17.9	25.0
1932	17.1	18.9	21.0	23.8	23.4	19.8	15.5	14.3	14.6	13.3	12.8	12.1	17.2
1933	12.6	14.8	17.3	19.7	21.3	18.4	14.8	12.5	17.8	12.0	11.2	11.0	15.3
1934	12.4	16.4	22.3	23.4	22.5	20.0	18.1	15.8	16.5	10.4	14.9	15.1	17.3
1935	16.2	21.4	23.7	23.8	17.8	21.0	16.5	16.6	18.8	18.9	18.6	18.3	19.3
1936	19.8	21.3	23.0	26.5	24.8	21.6	18.5	16.2	17.3	17.0	15.8	16.1	19.8
1937	19.6	21.7	23.8	25.5	24.4	24.9	22.1	22.7	20.7	20.3	20.9	19.8	22.2
1938	21.9	21.8	22.9	24.9	23.3	15.3	17.1	16.0	17.7	17.0	15.9	16.6	19.2
1939	16.6	17.1	20.4	20.5	18.9	16.8	17.2	14.3	16.8	15.8	15.3	14.8	17.0
1940	15.8	17.1	18.3	19.2	21.3	19.7	17.0	16.3	16.3	15.5	16.3	15.7	17.4
1941	16.1	16.8	18.8	20.8	19.6	19.0	20.3	19.8	20.1	20.3	20.5	21.8	19.5
1942	22.0	22.5	22.4	25.7	25.9	26.1	24.6	25.3	26.3	26.4	27.4	28.1	25.2
1943	31.3	32.0	34.0	31.6	30.1	28.5	30.9	30.9	30.9	30.9	30.9	30.9	31.1
Avg.	18.6	20.8	23.2	26.3	23.4	21.4	19.8	18.6	17.1	18.2	18.4	18.3	20.4

INDEX OF MONTHLY PRICES OF CHICKENS AT NEW ORLEANS

1931-1943

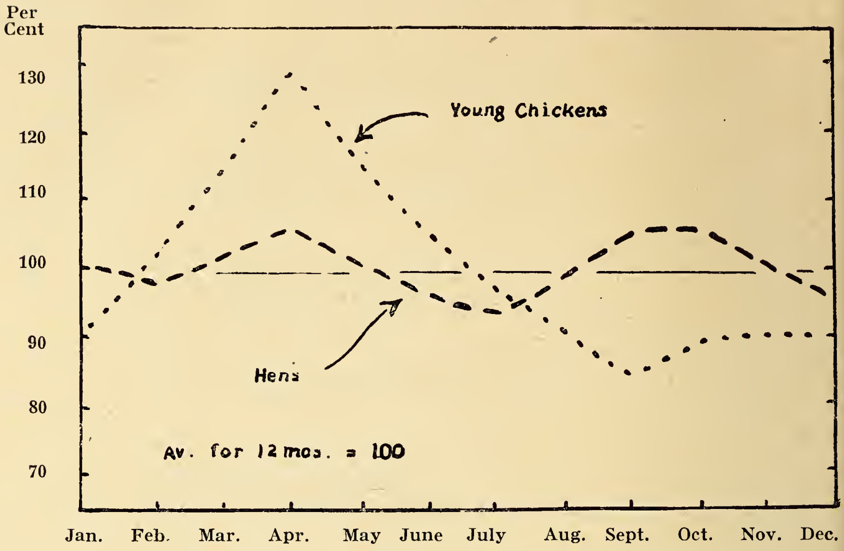

FIGURE 1

INDEX OF YEARLY PRICES OF CHICKENS AT NEW ORLEANS

1931-1943

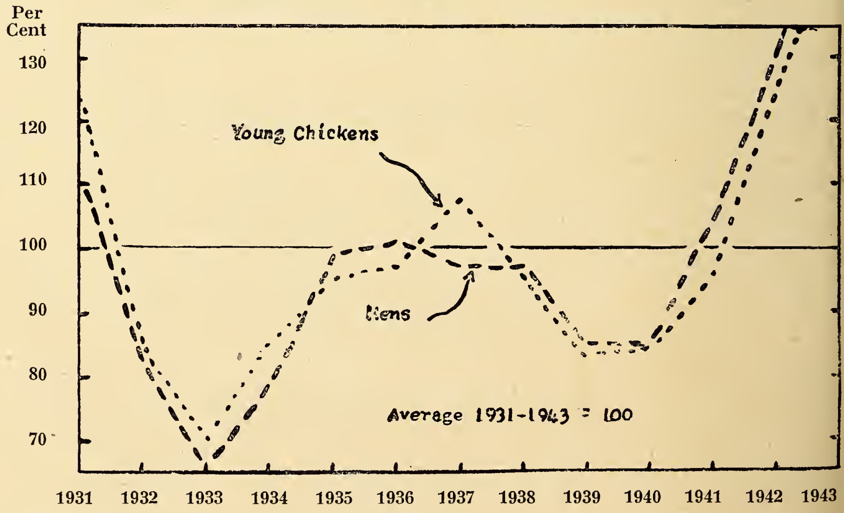

FIGURE 2

PRICES OF TURKEYS

Turkeys comprise about 10 per cent of the total poultry receipts at New Orleans, according to the Board of Health records taken at the inspection station in 1940. The seasonal receipts checked at the station in that year are shown in Table 4.

TABLE 4. AMOUNT OF TURKEYS RECORDED AT THE BOARD OF HEALTH INPECTION STATION, NEW ORLEANS, BY CLASSES AND BY SEASONS IN 1940

Class	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Year
			Pounds		
Hens	45,900	56,851	19,840	353,119	475,710
Toms	16,727	18,387	4,150	317,225	356,939
Total	62,627	75,688	23,990	670,344	832,649
			Per Cent		
Hens	9.6	12.0	4.2	74.2	100.0
Toms	4.6	5.3	1.2	88.9	100.0
Percent of Yr.	7.5	9.1	2.9	80.5	100.0

Turkey Hens

The prices of turkey hens at New Orleans are higher in December, January, February and March than during other months of the year (Table 5). This is due to the retention of hens on the farms during the first quarter of the year for breeding purposes. The low price in summer is due chiefly to the supply of good chickens. The price increases from September through December are the result of a good demand for turkeys. The demand is usually accompanied by a relatively heavy seasonal supply.

Toms

Seasonal variations in the prices of toms, or gobblers as they are termed in the price quotations, are about the same as in the case of turkey hens. One exception, however, is that the relatively high price for toms in the spring is due to scarcity at the market. The young male birds are quoted, on the average, about one half cent a pound below the price of turkey hens, or about one and one half cents a pound above the price of old toms. The monthly and yearly variations in prices of turkey hens are shown graphically in Figures 3 and 4.

TABLE 5. MONTHLY PRICES OF TURKEY HENS AS QUOTED FOR WHOLESALE MARKETS AT NEW ORLEANS

(CENTS A POUND)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1931	30.6	30.4	28.6	26.8	22.8	20.8	18.0	20.0	20.4	20.4	20.9	22.3	23.5
1932	20.8	17.6	17.0	16.2	14.2	13.3	12.2	12.6	13.3	16.7	17.0	12.8	15.3
1933	11.6	12.2	12.3	12.3	11.8	10.6	10.8	10.5	11.0	11.5	12.8	13.5	11.7
1934	14.3	14.8	15.0	13.3	13.0	12.0	12.6	12.6	13.4	14.6	16.4	18.0	14.2
1935	19.3	20.0	21.3	18.9	17.5	17.4	16.3	16.6	17.0	17.5	19.3	23.6	18.7
1936	24.8	24.5	24.0	21.0	16.8	17.6	18.1	18.0	17.9	18.6	17.3	15.7	19.5
1937	17.3	17.8	17.6	16.6	14.9	14.8	15.2	15.6	16.9	18.5	17.9	18.8	16.8
1938	20.4	20.5	20.2	16.9	16.5	15.5	15.0	15.3	16.8	17.8	17.0	19.8	17.6
1939	23.3	22.3	20.6	17.3	16.7	16.0	16.0	16.0	16.1	16.7	15.3	14.9	17.6
1940	13.8	14.3	15.3	13.2	12.3	12.3	12.1	12.5	14.9	15.9	15.4	16.5	14.0
1941	17.0	17.4	18.0	16.7	15.2	15.0	15.3	15.7	17.4	19.4	20.0	23.1	17.5
1942	22.0	21.0	21.5	19.7	18.3	19.0	20.0	20.0	20.0	24.0	28.0	29.5	21.9
1943	34.5	33.5	33.3	33.6	34.0	33.3	36.9	36.9	36.9	36.9	36.9	36.9	35.3
Avg	20.7	20.5	20.4	18.6	18.2	16.7	16.8	17.1	17.8	19.1	19.5	20.4	18.8

INDEX OF MONTHLY PRICES OF TURKEY HENS AT NEW ORLEANS

1931-1943

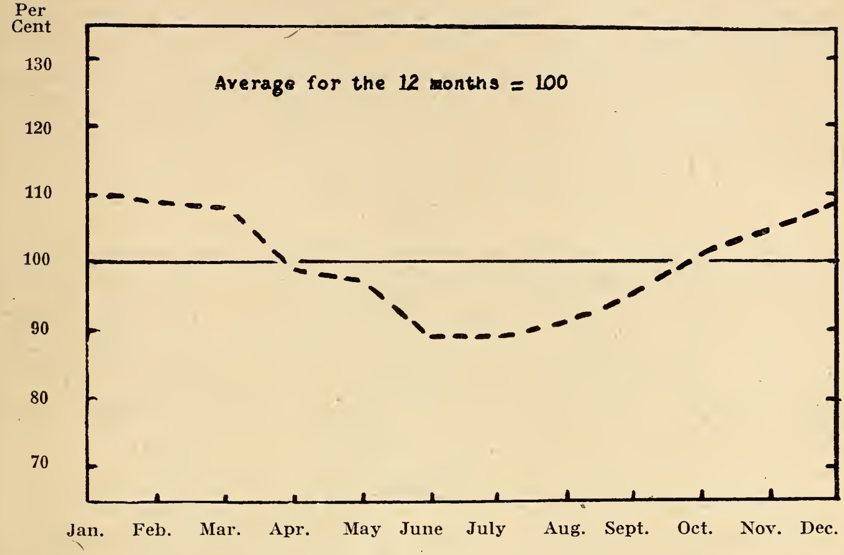

FIGURE 3

INDEX OF YEARLY PRICES OF TURKEY HENS AT NEW ORLEANS

1931-1943

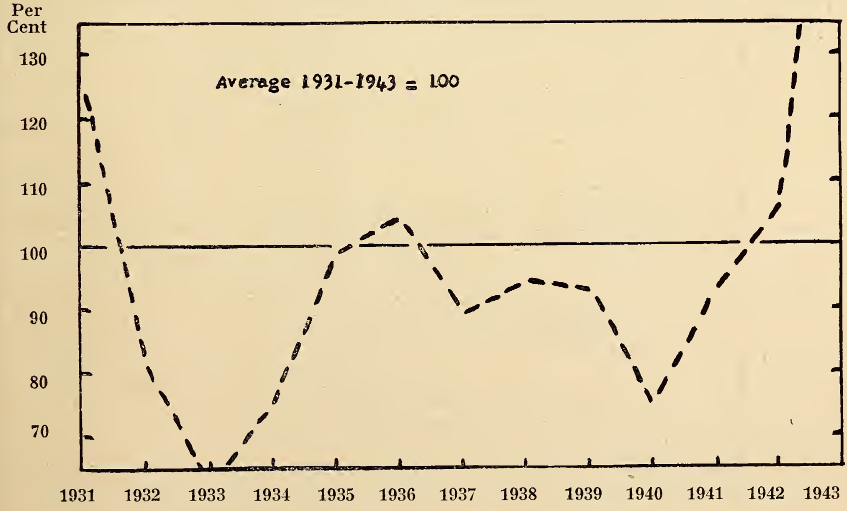

FIGURE 4

PRICES OF GEESE AND DUCKS

Geese and ducks together at the New Orleans markets probably constitute less than one per cent of the total supply of poultry. They are not divided into classes or grades. The seasonal receipts vary about the same as the seasonal receipts of turkeys. The prices of geese and ducks at New Orleans for the period, 1931-1943, are shown in Tables 6 and 7, respectively. The monthly and yearly variations in prices are charted in Figures 5 and 6.

Geese

The average price of geese for the period 1931-1943 moved rather steadily from a high point of 12.0 cents a pound in January to a low average of 10.1 cents in August and September. The higher prices in the winter months are due to good demand and good quality of geese. Declining prices in the spring are the result of a supply of good chickens. Low prices in the summer may be assigned chiefly to small demand and off-season for geese.

Ducks

In quoting the prices of ducks at New Orleans little distinction, if any, is made in breeds. The best stage at which to market ducklings is when they are "finished", or full-fleshed, and before heavy pin feather development starts. In Louisiana, pin feathers usually appear at the

Index of Monthly Prices of Geese and Ducks at New Orleans

1931-1943

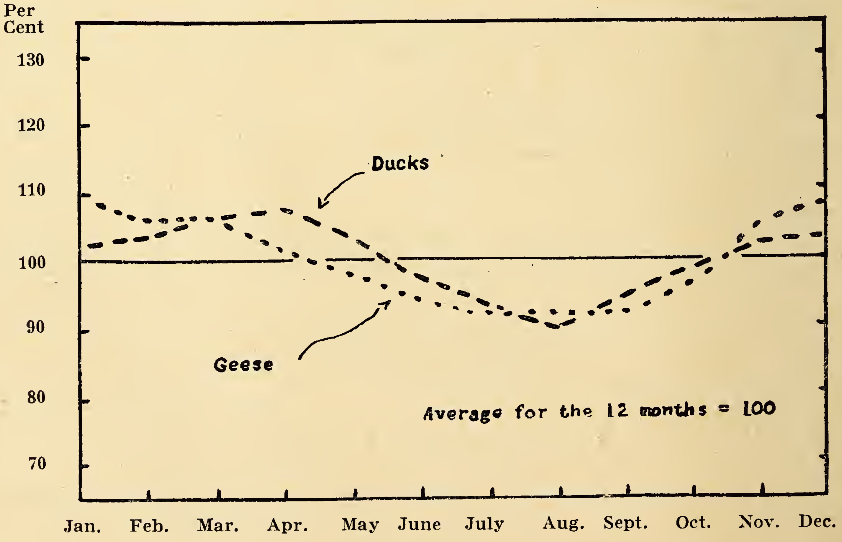

Figure 5

TABLE 6. MONTHLY PRICES OF GEESE AS QUOTED FOR WHOLESALE MARKETS AT NEW ORLEANS, 1931-1943
(CENTS A POUND)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1931	12.5	10.0	10.0	10.0	10.0	10.0	13.0	13.0	10.0	10.3	10.8	10.0	10.8
1932	10.0	10.0	9.2	9.3	9.5	9.2	8.5	8.0	8.0	8.7	9.1	8.2	9.0
1933	8.0	7.6	7.1	7.4	7.1	7.1	6.4	6.5	6.3	6.6	8.1	8.4	7.2
1934	9.0	9.3	8.9	8.4	8.1	7.7	7.1	7.3	7.8	8.2	9.1	9.3	8.3
1935	9.2	9.8	10.0	10.1	9.4	8.6	8.1	8.1	8.5	9.6	10.5	11.3	9.4
1936	11.3	10.5	10.9	11.3	10.6	10.3	9.6	8.9	8.5	9.3	11.4	11.4	10.3
1937	11.4	11.3	11.4	11.3	11.3	10.8	10.3	10.3	10.3	10.3	11.3	12.8	11.0
1938	12.5	12.3	12.3	10.9	10.6	8.9	8.3	8.3	8.3	9.8	10.8	11.8	10.4
1939	11.9	11.1	11.3	10.5	9.9	8.4	8.3	8.5	9.1	10.0	10.3	11.0	10.0
1940	10.8	10.3	10.5	10.2	9.3	9.0	8.5	8.5	9.3	10.0	10.7	11.1	9.8
1941	10.9	10.9	11.3	11.3	11.2	10.3	10.3	10.4	11.1	10.9	12.7	12.6	11.1
1942	12.5	12.4	12.9	12.8	12.5	12.4	12.5	12.5	12.6	13.0	13.9	15.6	13.0
1943	26.1	26.0	26.5	21.0	21.0	21.1	21.4	21.4	21.4	21.4	21.4	21.4	22.5
Avg.	12.0	11.6	11.7	11.1	10.8	10.3	10.2	10.1	10.1	10.6	11.5	11.9	11.0

age of 12 to 16 weeks. The prices of ducks are determined mainly by supply and quality. The seasonal changes in prices of ducks coincide closely with the changes in the prices of geese. New Orleans is reported as not being an especially good market for ducks.

INDEX OF YEARLY PRICES OF GEESE AND DUCKS AT NEW ORLEANS

1931-1943

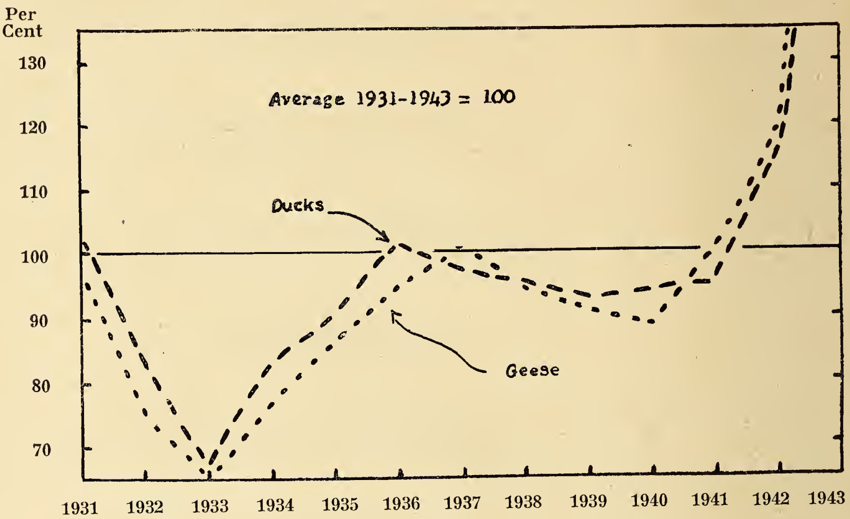

FIGURE 6

PRICES OF EGGS

The only eggs for which price quotations were available for the entire period involved in this report are the common run of Louisiana eggs and quoted at the wholesale markets of New Orleans as "current receipts." These lots of eggs are usually ungraded as to size, color, cleanliness and oftentimes freshness. They are sometimes referred to as "yard eggs," "country eggs" or "market run" eggs. The average monthly and yearly prices of current receipt eggs, which are referred to below as just "eggs," for the period, 1931-1943, are presented in Table 8. The indexes of these prices are charted in Figures 7 and 8.

The highest average monthly prices of eggs at New Orleans during the period were in December and the lowest monthly prices were in June. This differs from Louisiana farm prices of this quality of eggs which drop to the lowest price level in March. The low price in June at New Orleans is due mainly to poor quality of eggs, and the low farm price in March is due to heavy seasonal supply and congestion in the rural areas. Part of the heavy March farm supply is taken up by packers and others for storage which reduces the deliveries

TABLE 7. MONTHLY PRICES OF DUCKS AS QUOTED FOR WHOLESALE MARKETS AT NEW ORLEANS, 1931-1943
(CENTS A POUND)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1931	18.0	17.0	17.5	16.0	14.0	13.6	14.0	13.3	14.6	14.5	14.0	13.8	15.1
1932	14.5	14.3	12.0	12.0	11.0	10.2	9.0	9.0	9.5	10.0	10.4	10.8	11.1
1933	10.0	10.1	10.1	10.1	9.1	8.1	8.0	7.3	7.8	8.6	9.2	9.3	9.0
1934	10.1	10.3	11.0	11.0	10.9	10.3	9.8	8.3	9.3	10.4	11.3	11.3	10.3
1935	11.6	12.3	12.4	12.8	12.1	11.3	10.8	10.1	11.3	12.3	12.9	13.6	11.9
1936	14.4	15.6	16.1	16.6	14.3	12.8	12.0	11.6	11.5	11.5	12.9	12.3	13.5
1937	12.4	12.3	12.6	12.9	14.9	14.8	11.3	11.8	12.3	12.9	13.5	13.3	12.9
1938	14.0	13.8	13.7	12.8	13.6	11.8	12.4	11.3	10.9	11.6	12.5	12.8	12.6
1939	13.4	13.5	13.9	13.8	12.7	10.8	10.8	10.8	12.3	12.3	12.3	11.9	12.4
1940	11.8	11.8	12.5	12.5	12.3	11.7	10.4	10.8	11.7	12.6	12.4	12.1	11.9
1941	12.3	12.9	13.2	14.3	13.3	12.3	11.8	11.3	11.9	12.0	13.1	13.6	12.7
1942	14.4	14.9	15.6	15.6	15.4	15.2	15.5	14.9	15.2	15.9	16.6	17.6	15.6
1943	19.0	19.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	24.0
Avg.	13.5	13.7	14.3	14.3	13.7	12.9	12.4	11.9	12.5	13.0	13.5	13.6	13.3

to New Orleans at that time. The steady movement upward to an average for the 13-year period of 28.2 cents a dozen in December may be attributed to a relatively short supply, increased demand and better quality of eggs. But the price is checked by the competition of storage eggs, many of them from Louisiana as well as from other parts of the country. Because of low production in late fall and winter in Louisiana and less competition from storage eggs, the price of eggs in the rural areas in December may equal or even exceed the prices at New Orleans.

With production at a peak in the spring and extremely low in the fall and winter, producers realize lower yearly average prices for their eggs than if production were more evenly distributed throughout the year. It is obvious also that the extremely low farm prices in the spring may be improved somewhat by better marketing facilities. More careful grading and packing with larger volume shipments without doubt would stimulate the market demand for Louisiana eggs and thereby net producers more profit.

Much of the egg supply at New Orleans originates in Texas. These eggs are of the "current receipt" type but appear to be better assorted and more carefully candled than the eggs from Louisiana. For this difference Texas eggs at New Orleans demand a premium of one to two cents a dozen over Louisiana current receipt eggs.

INDEX OF MONTHLY PRICES OF LOUISIANA CURRENT RECEIPT EGGS
NEW ORLEANS, 1931-1943

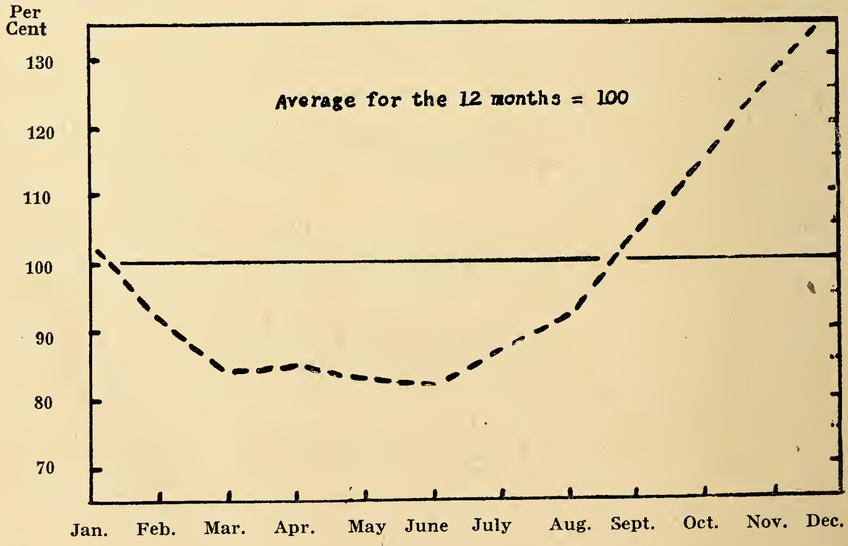

FIGURE 7

TABLE 8. MONTHLY AND YEARLY PRICES OF LOUISIANA CANDLED EGGS —
WHOLESALE MARKETS AT NEW ORLEANS, 1931-1943
(CENTS A DOZEN)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1931	23.4	16.2	19.5	16.2	14.5	15.8	17.3	17.3	20.0	22.3	26.0	28.0	19.7
1932	18.9	13.2	10.5	10.1	9.7	9.8	13.6	16.5	18.3	21.1	23.1	27.8	16.0
1933	21.6	10.8	10.3	9.8	10.3	9.9	12.0	12.0	13.8	16.3	21.3	25.0	14.4
1934	20.4	14.3	14.0	13.9	13.4	12.0	12.6	14.3	18.8	20.7	23.6	25.8	17.0
1935	25.3	25.1	18.3	20.0	20.8	18.4	19.0	18.0	21.1	23.3	24.1	25.2	21.5
1936	21.0	21.3	16.0	16.1	16.8	17.3	17.8	19.0	22.6	24.1	29.5	30.8	21.0
1937	23.8	19.8	19.3	19.2	15.6	16.8	14.6	16.0	17.8	20.3	21.0	25.6	19.1
1938	20.5	15.3	14.8	15.6	15.1	14.5	14.3	15.3	16.9	18.7	24.0	26.0	17.6
1939	19.6	15.0	14.3	15.8	13.9	13.0	12.1	12.3	13.8	15.0	18.0	18.3	15.1
1940	18.3	19.3	13.8	13.9	13.8	12.0	12.5	13.9	16.6	17.8	19.8	22.7	16.2
1941	18.0	14.3	14.9	17.3	17.7	20.3	22.2	21.7	23.8	25.2	28.3	31.3	21.3
1942	31.1	24.6	24.6	24.5	25.4	25.8	24.5	26.0	30.0	34.6	35.6	36.9	28.6
1943	38.3	34.7	34.2	34.1	34.0	33.3	39.0	41.4	42.3	43.0	44.0	43.2	38.5
Avg.	23.1	18.7	17.2	17.4	17.0	16.8	17.8	18.7	21.3	23.3	26.0	28.2	20.5

INDEX OF YEARLY PRICES OF LOUISIANA MONTHLY CURRENT RECEIPT EGGS

NEW ORLEANS, 1931-1943

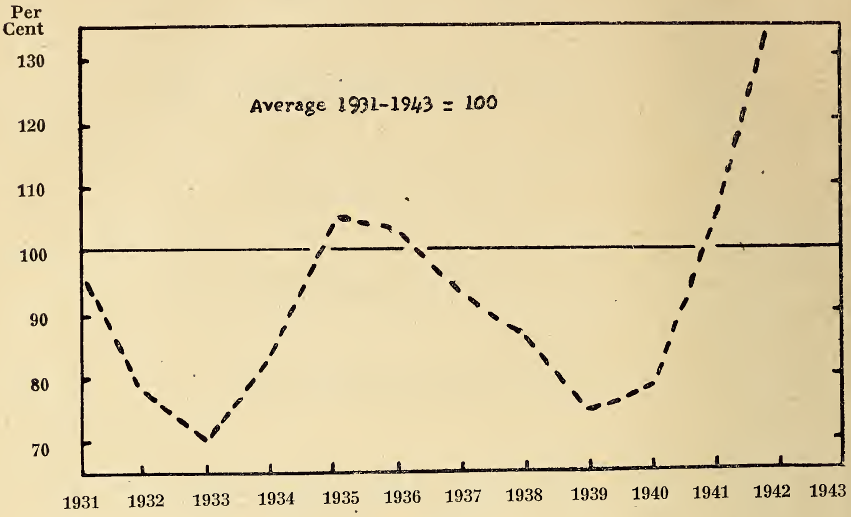

FIGURE 8

Prices of eggs from other states, of course, are subject to variations in quality and price also. Grade "A" eggs under ordinary conditions are priced about three cents a dozen above "current receipt" eggs at the New Orleans wholesale markets. Under O. P. A. regulations the margin is about 7 cents a dozen.

SUMMARY

The heaviest receipts of chickens at New Orleans, according to a partial report on total receipts by the Board of Health inspection station, are during the third quarter of the year with an average of 28 per cent. of the year's supply. The lowest receipts are in the first quarter. The seasonal price of hens, which constitute about 27 per cent of the total amount of poultry at this market, averaged highest in April at 18.1 cents a pound and lowest in July at 15.9 cents a pound. In November and December the prices of hens as well as other classes of chickens are affected by the competition of turkeys and rabbits. Springs and broilers comprised about 35 per cent of the chicken receipts at New Orleans in 1940. The highest receipts of springs were in the third quarter of the year. Springs averaged in price about 3 cents a pound and broilers about 5 cents a pound above the prices of hens.

Turkeys comprise about 10 per cent of the poultry receipts at New Orleans with the largest volume in the last quarter of the year. The best prices for turkeys are in December, January, February, and March. Prices are lowest in June and July.

Indications are that New Orleans is not an especially good market for geese and ducks. The best average price for geese for the 13-year period was in January at 12 cents a pound. The average price in summer was about 10 cents The price of ducks is 1.5 to 2 cents a pound above that of geese.

The prices quoted for eggs were for regular, "current receipts." The average price of these eggs for the period ranged from 28.2 cents a dozen in December to 16.8 cents a dozen in June. For this quality of receipts Texas eggs bring a premium of one to two cents a dozen above the prices of the eggs from Louisiana. This appears to be due chiefly to better candling and packing. Grade "A" eggs at the New Orleans wholesale markets net about 3 cents a dozen over "current receipts."

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STORAGE OF IRISH POTATOES IN THE LOWER SOUTH

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STORAGE OF IRISH POTATOES IN THE LOWER SOUTH

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INTRODUCTION

The Irish potato is the most important vegetable crop, so it is only natural that storage problems concerning it have received a great deal of attention at the hands of investigators. No attempt will be made here to fully cover the literature on the subject of Irish potato storage. That Irish potatoes can, if properly handled, easily be kept in cold storage, has been well demonstrated. Probably the best general storage temperature for Irish potatoes is 40°F. As the storage temperature does not remain exactly constant in cold storage, a range of 38° to 40° F. is recommended. Sugars accumulate in potatoes stored at low temperatures and this change occurs to some extent at 40° F. Accumulated sugars injure the quality of Irish potatoes. Varieties differ to some extent in the amount of sugars present under cold storage conditions as was pointed out by Denny and Thornton (2). The amount of glucose sugar present in potatoes determines their fitness for making potato chips. The less glucose present the better. When potatoes are brought out of cold storage and kept at moderate temperature for several days the sugars which accumulated in cold storage tend to change back to starch and the cooking quality will be improved. There is however a varietial difference in the rapidity and extent of this change. When potatoes are brought from cold storage to higher temperatures there is a period of a few days of excessively high rate of respiration in the tubers and good ventilation is especially important during this time.

Wounds on potatoes heal and the skins suberize, or develop cork, more readily at temperatures between 65° F. and 70° F. with very high relative humidity. For this reason potatoes should not be put into cold storage immediately after digging, but should be kept in a cool, well ventilated place for several days. If this is not done, decay organisms may be very injurious to the tubers even in cold storage.

Potatoes grown in the lower South are not stored commercially to any appreciable extent. Interest in the storage of potatoes in this area is somewhat different from that further north. Here Irish potatoes are grown primarily as an early truck crop and shipped to market immediately after harvest. Potatoes are often dug while immature and must at least be considered a semi-perishable product. Growers are not interested in cold storage, except in seasons of very low prices. Even then cold storage cannot be recommended for potatoes that are to be shipped to out-of-state markets later, for the potatoes removed from storage would have to compete with the crop grown in areas nearer the markets. Cold storage costs and transportation of potatoes to and from storage would be expensive. Potatoes removed from cold storage in hot weather must be handled properly or they are likely to break down and be lost. Cold storage space is not generally available in the South to accomodate much of the potato crop, if such storage were desirable. A few years ago Miller (6) showed that Irish potatoes grown in the spring in southern Louisiana and kept in cold storage during the summer made excellent seed potatoes, if free of virus diseases, in areas further south that planted in September and October. Small whole potatoes 1½ to 1⅞ inches in diameter were used and these were certified. This gave an outlet for the smaller potatoes at better prices than could be obtained for them on the market as table stock potatoes. Some growers were interested in storing potatoes from the spring crop for use as seed for planting for the spring crop the next year. If this could be done satisfactorily and cheaply enough, the grower could store usable culls and small potatoes more economically than buying certified seed every year. To obtain information on this subject the cold storage part of the investigations here reported was conducted.

Not many weeks after the spring crop of Irish potatoes is harvested in the lower South, locally grown potatoes are scarce and potatoes are shipped in from other producing areas. Potatoes of the Triumph variety, the main commercial one that is grown in Louisiana, are not supposed to be very good keepers. Work with common storage of Irish potatoes during the summer was undertaken to work out means of keeping potatoes for fall planting and, if possible, until fall potatoes are dug. This would help with the food problem of many rural people. It would also permit the sale of home grown potatoes on a limited scale, mostly locally, during the summer.

Most of the spring Irish potato crop in Louisiana is grown from northern certified seed. A limited acreage, however, is planted with locally grown fall potatoes. The crop from this type of seed, if it has received no special treatment, is late and quite variable in yield. Fall potatoes used as seed usually produce a good crop only when growing conditions are favorable late in the season and earliness is an important factor for potatoes that are to be shipped. Jehle and Walker (4) in Maryland found that increasing the storage temperature of late grown seed potatoes stimulated sprout growth. The amount of stimulation depended on the increase in temperature and the time of exposure. In Louisiana (7) it was found that fall grown potatoes kept at temperatures ranging from 60° to 75° F. produced higher yields when used as seed potatoes than did those kept in common storage without any artificial heat. Information on the effect of controlled storage temperatures for fall potatoes seemed desirable.

The storage investigations here reported are divided into three parts: (1) cold storage, (2) common storage in summer, and (3) high temperature storage of fall potatoes.

COLD STORAGE STUDIES OF IRISH POTATOES

Literature Cited

Wright and Peacock (10) found that potatoes were injured if they were stored at 32° and 36° F. within three days after they were dug. Smith (8) states that tubers that were stored 8 to 12 days at 63° to 68° F. lost less weight and the loss from decay was not as great in subsequent storage as those that were stored the same length of time at temperatures of 39° to 44° F. Hartman (3) found that a constant temperature of 40° F. appeared better for seed potatoes than a constant temperature of 35° F. and a constant temperature of 35° F. than a constant temperature of 32° F. Stuart, Lombard, and Peacock (9) found that there was considerably less rot in potatoes stored for two years at 40° F. than in lots of potatoes stored at 36° F. and 32° F.

Bushnell (1) found that the number of sprouts per seed piece was influenced by the length of time between digging and planting, storage temperature and humidity, and the weight of the cut seed piece.

The writer (5) in a preliminary report on some of this work showed that potatoes of the Katahdin variety produced proportionately higher yields, when used as seed after being kept in cold storage than did those of the Triumph, Chippewa, and Houma varieties.

Procedure

The first two years of the experiment potatoes were kept in a commercial cold storage plant at a temperature of 40° F. This was the only cold storage available at the time. The next two years storage rooms with temperatures controlled at 35° and 40° F. respectively were used. No higher temperatures were used because it was known that potatoes would sprout and shrivel badly at temperatures above 40° F. during the storage period that would be necessary. Potatoes were put into cold storage the day after digging, two days later, and after one, two and three weeks respectively. They were kept in a well ventilated shed before they were put in cold storage. Five bags of No. 1 potatoes were placed in storage at each time and place. Before planting time total shrinkage and percentages of rot were determined.

Potatoes were removed from storage two weeks before planting, one week before planting, and the day of planting. Potatoes from the different treatments were used to plant experimental plots. The plots used were 4 by 40 feet and each treatment was replicated five times. Records were kept on germination, sprouts produced, and yields. Northern certified seed was used as checks. The Triumph variety was used except for a test which included a few varieties.

Moisture determinations were made by drying alcohol covered samples to constant weight in a drying oven at 95° C. Sugar determinations were made by the Bertrand modification of the Munson and Walker method. Starch was determined by the acid hydrolysis method. The Kjeldahl method was used for the determination of total nitrogen.

EXPERIMENTAL RESULTS

Shrinkage in Storage

Only the results obtained for the two years when the two controlled temperatures were available will be presented, as it is not believed the other two years would affect the conclusions reached. The results on shrinkage are shown in Table 1.

These results show that shrinkage and rot were greater in potatoes put into cold storage one to three days after digging than in those kept at a higher temperature for a time before storage. This means that potatoes should not be put in cold storage until one to two weeks after they are dug. Differences were not as striking in potatoes stored at 40° F. as in those kept at 35° F. Total shrinkage and decay were very high in potatoes that were stored at 35° F. within three days after digging. As has been explained by others this excessive loss is due to the imperfect healing of wounds and suberization of the skin at low temperatures. This allows excessive evaporation of moisture from the tubers and affords a source of entry for decay organisms. The proper temperature for keeping potatoes before they are put into cold storage is 65° to 70° F. In the lower South it is not always possible to keep potatoes at this temperature range, especially during the day, at harvest time on the farm. It is recommended that they be kept in a shed or building that can be given good ventilation and will protect the potatoes from rain.

Another advantage to waiting a week or two before putting potatoes into cold storage is that the period of greatest physiological shrinkage in potatoes is the first few days after they are dug. This means that there will be less shrinkage during the cold storage period and charges will not be so much on tonnage that is lost.

Potatoes were kept in cold storage satisfactorily until planting time and if handled properly total shrinkage was not excessive and loss from rot was negligible. A storage temperature of 40° F. was better than 35° F. for storing Irish potatoes.

Table I. Shrinkage of Irish Potatoes in Cold Storage

Interval Between Digging and Cold Storage	Season of 1937-1938						Season of 1938-1939					
	Total Shrinkage Per Cent				Rotted Potatoes Per Cent		Total Shrinkage Per Cent				Rotted Potatoes Per Cent	
	May 25 to June 15		May 25 to Jan. 21		January 21		May 12 to May 26		May 12 to Jan. 28		January 28	
	35°F.	40°F.	35°F.	40°F.	35°F.	40°F.	35°F.	40°F.	35°F.	40°F.	35°F.	40°F.
1 day	5.6	4.6	24.0	10.3	26.6	3.6	5.2	2.5	28.6	10.8	29.9	1.5
3 days	5.1	4.2	20.0	9.8	13.8	1.7	4.8	2.8	21.6	10.9	20.8	1.0
1 week	4.3	4.1	11.8	7.2	2.7	1.1	4.0	3.0	17.1	9.8	9.2	0.3
2 weeks	4.0	4.0	7.8	6.8	1.4	0.5	2.6	2.8	10.8	8.2	6.0	0.6
3 weeks	4.0	4.2	7.1	7.1	0.6	0.2	—	—	9.7	7.2	2.4	0.3

Effect of Cold Storage Treatment of Seed Potatoes on Yields

Again only the results obtained from the two seasons when potatoes were kept at controlled temperatures of 35° and 40° F. will be presented. The effect of time of removal from storage before the potatoes were planted is shown in Table 2. No significant differences in yields were obtained that could be attributed to time of removal of potatoes from storage. Seed pieces from potatoes removed from storage the day before planting did not sprout as rapidly as those from potatoes that had been removed for one or two weeks. This was a temperature-sprout-growth relationship. The data in Table 3 show that there were no significant differences in yields due to the time interval before the potatoes were put in cold storage. Neither Table 2 nor Table 3 show any significant differences in yields due to storage temperature. They do show that yields from northern certified seed were very significantly higher than the yields produced from potatoes kept in cold storage.

TABLE 2. EFFECT OF STORAGE TEMPERATURE AND TIME OF REMOVAL FROM STORAGE ON YIELD OF TRIUMPH IRISH POTATOES

Time of removal from storage	Yields in bushels per acre—two year average* for seasons of 1938 and 1939								
	Kept of 35°F.			Kept of 40°F.			Northern certified		
	No.1	No.2	No.3	No.1	No.2	No.3	No.1	No.2	No.3
Day before planting	61.0	28.5	10.3	62.3	29.3	9.6	149.5	24.3	6.1
One week before planting	67.8	35.0	11.2	62.0	29.7	9.4	142.0	26.5	7.7
Two weeks before planting	61.1	32.3	9.1	55.3	32.2	8.6	128.7	27.5	8.5

* Five series of five plots were used each year to obtain these averages for potatoes grown from tubers kept in cold storage.

The effect of the long cold storage period on the production of sprouts per seed piece is shown in Table 4. The data show that the number of sprouts produced from seed pieces from cold storage potatoes was larger than from northern certified seed. The largest number of sprouts was produced from the No. 2 whole potatoes. This might be expected because there were more eyes present on this seed and during the long storage season apical dominance had been destroyed. The number of sprouts produced per seed piece influences the number of tubers set and the set influences the size of the potatoes. While individual hills of potatoes often produced 6 to 8 sprouts the average number of sprouts per hill as shown in the table, except for No. 2 whole potatoes, was not extremely high. The size of the seed piece had some influence on the number of sprouts produced. Again the lower yields produced from cold storage seed compared with those from northern certified is very apparent in Table 4. It is not believed that multiple sprouting was the important factor in bringing about this difference. Seed from cold storage potatoes, if removed from storage one to two weeks before planting, sprouted rapidly and for a time the plants made good growth, better than plants from northern certified seed. This good growth did not continue though and plants from cold storage seed stopped growing while those from northern certified seed continued to grow. The plants from cold storage seed matured while the potatoes were generally small and conditions were favorable for growth for plants from certified seed.

TABLE 3. EFFECT OF STORAGE TEMPERATURE AND TIME OF PLACING TRIUMPH IRISH POTATOES INTO STORAGE ON YIELD OF CROP

Time of Placing in Cold Storage	Yield in bushels per acre—two year average* for seasons of of 1938 and 1939					
	Kept at 35°F.			Kept at 40°F.		
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
Day after digging	62.0	34.0	11.3	67.9	26.6	7.7
Two days later	68.0	36.3	9.7	60.0	30.7	7.8
After one week	68.0	31.1	9.4	57.7	29.8	9.2
After two weeks	58.2	31.4	10.2	56.7	35.8	10.5
After three weeks	60.0	29.4	10.2	58.0	30.2	10.3
Northern certified	140.0	26.1	7.6			

TABLE 4. EFFECT OF STORAGE AND SIZE OF SEED PIECE ON THE NUMBER OF SPROUTS PRODUCED AND YIELD OF TRIUMPH IRISH POTATOES

Type of Seed		Ave. No. of sprouts per seed piece and bushels per acre yields					
		1937			1938		
		No. of sprouts	Yield per acre		No. of sprouts	Yield per acre	
			No. 1's	No. 2's		No. 1's	No. 2's
No. 2 whole potatoes (1½ oz.)	40°F.	4.03	54.1	41.7	3.9	84.0	59.5
No. 2's cut in half	40°F.	2.24	72.0	34.0	2.5	55.3	54.3
No. 1's cut to 1½ oz. size	40°F.	2.63	57.4	42.6	2.9	69.4	57.8
No. 1's cut to 1 oz. size	40°F.	2.11	48.7	44.8	2.7	61.8	52.9
No. 1's cut to ¾ oz. size	40°F.	1.67	51.4	30.4	1.8	74.7	42.6
Northern Certified 1 oz. pieces		1.82	158.4	39.7	1.5	151.5	34.9

The cultural treatment was of course the same in both cases. If only one sprout was left per hill on seed pieces from cold storage potatoes, it made no more noticeable growth than if other sprouts had not been removed. One year some northern certified seed was kept in cold storage and planted for the fall crop. These tubers produced multiple sprouts worse than anything previously tested and did not make a normal growth. Seed pieces from potatoes kept in cold storage for two years produced very poor stands of plants that made a very weak growth and practically no yield. It should be pointed out that there was no appreciable injury to plants from virous diseases during the course of this work. It seems very likely that some change takes place in potatoes which is materially affected by the length of the dormant period. This may be due to a change in some harmone or growth promoting substance within the tuber. Whatever the cause, the results are important to the grower of early Irish potatoes in the South. Certified seed produced in areas dug at different times may be expected to behave differently and this seems to be true. With the same storage treatment potatoes that have a longer dormant period may be expected to mature more quickly but the yield may be correspondingly reduced. What has been said refers to potatoes of the Triumph variety, but several other varieties have been worked with, and, so far, the Katahdin is the only one that has behaved differently. This difference has been referred to previously.

Change in Composition of Irish Potatoes in Cold Storage

Samples were taken at intervals to determine some of the changes in composition of tubers. Some of the data obtained for one season, which are fairly typical of those obtained other seasons, are given in Table 5.

TABLE 5. CHANGES IN STORAGE OF THE COMPOSITION OF TRIUMPH IRISH POTATOES DUG JUNE 2, 1936

Date sampled	Type of storage	Moisture per cent	Sugar per cent		Starch per cent	Nitrogen per cent
			Reducing	Total		
June 2, 1936	———	83.73	Trace	0.42	12.15	0.171
June 5, 1936	Common	82.00	Trace	0.49	12.96	0.164
June 11, 1936	Common	82.50	0.06	0.60	12.38	0.164
June 17, 1936	Common	82.15	0.08	0.82	12.01	0.170
June 17, 1936	Cold*	83.60	0.75	2.01	11.16	0.147
June 24, 1936	Common	83.31	0.08	1.00	11.25	0.152
June 24, 1936	Cold	83.78	1.33	2.44	10.03	0.145
Aug. 3, 1936	Common	83.19	0.11	1.18	12.15	———
Aug. 3, 1936	Cold	82.94	1.58	3.25	10.08	———
Dec. 8, 1936	Cold	83.60	1.82	3.22	9.72	———
Feb. 11, 1937	Cold	83.25	1.96	3.06	9.18	———
Feb. 11, 1937	Northern Certified Seed	78.30	0.22	0.50	14.40	———

* Commercial storage 40 °F.

The data show, as has been found many times before, that at digging time the potatoes contained very little sugar but that the amount increased after they were dug. In cold storage the amount of sugar increased considerably and starch correspondingly decreased. The moisture content did not change appreciably during the season. The difference in moisture content of Louisiana spring grown potatoes and northern grown certified potatoes was considerable. The moisture content of western dry land potatoes is likely to be lower than in other large commercial areas. The fact remains, however, that early southern grown Irish potatoes, especially when high yields are produced, do contain a relatively high moisture content. This means a difference in actual food value of the tubers and it is important from a dehydration standpoint. It may also play a part in the keeping of the potatoes.

COMMON STORAGE OF POTATOES IN THE SUMMER

Procedure

Three types of storage places were used in this investigation. One was a large well ventilated sweet potato storage house that had a dirt floor. The first two years a house located at Lewisburg was used. The third year a house near St. Francisville was used. Another type was a large brick warehouse located at Donaldsonville. The part of this warehouse that was used in 1940 was well ventilated but the part used in 1941 was not well ventilated. The warehouse was not used as a place of storage in 1942 due to transportation difficulties. The other place of storage was in a large cattle shed back of the Agricultural Center at L. S. U. In this location hardware cloth was used to protect the potatoes from rats and mice. Potatoes were stored in sweet potato crates. Forty pounds of potatoes were placed in each crate. The first year of the experiment the potatoes had been dug two weeks before the experiment was started. The next two years they were weighed into the crates the day after they were dug. They were left in storage until the sweet potato houses had to be gotten ready for sweet potatoes. By that time the hot summer weather was over. Two varieties, Triumph and Katahdin, were used in this test.

Experimental Results

The results of the three years tests are given in Table 6. The data show that both varieties kept very well during the summer in the types of common storage used. There was consistently a little less shrinkage in the tubers of the Katahdin variety than in those of the Triumph variety. The Triumph potatoes rotted significantly more than did those of the Katahdin variety. The gross shrinkage during the period of storage was considerable, approximately 15 to 20 per cent. This loss must be especially considered by those interested in storing potatoes on a commercial scale. About September 1 the sprouts on the potatoes

TABLE 6. SHRINKAGE AND ROT IN TRIUMPH AND KATAHDIN IRISH POTATOES KEPT IN COMMON STORAGE DURING THE SUMMER

Place of storage	Variety	1940 June 29 to Sept. 20		1941 May 28 to Sept. 26		1942 June 19 to Oct. 2	
		Shrinkage per cent	Rot per cent	Shrinkage per cent	Rot per cent	Shrinkage per cent	Rot per cent
Cattle shed	Triumph	6.19	3.41	15.58	6.32	21.54	6.13
Cattle shed	Katahdin	6.00	0.30	13.81	1.45	16.50	2.19
Brick warehouse	Triumph	7.00	4.09	21.17	6.80	—	—
Brick warehouse	Katahdin	5.58	0.90	18.58	0.89	—	—
Sweet Potato house	Triumph	7.45	2.69	15.89	7.20	21.20	11.82
Sweet Potato house	Katahdin	5.64	0.55	14.25	2.38	16.10	4.52

TABLE 7. MOISTURE CONTENT IN POTATOES KEPT IN COMMON STORAGE

Place of storage	Variety	1940 Moisture per cent		1941 Moisture per cent		1942 Moisture per cent	
		June 7	Sept. 21	May 27	Sept. 27	June 19	Oct. 2
Cattel shed	Triumph		82.68		82.29		83.84
Cattle shed	Katahdin		82.58		81.87		84.79
Sweet Potato house	Triumph	82.84	83.00	81.52	81.75	84.36	83.83
Sweet Potato house	Katahdin	82.03	81.69	79.59	82.00	86.44	84.64
Brick warehouse	Triumph		82.96		81.62		
Brick warehouse	Katahdin		82.66		81.31		

were very small, but the potatoes were still marketable. At the time of removal from storage the sprouts were approximately one-half inch long. The potatoes were still in good edible condition but were hardly good enough to market. The Katahdin potatoes sprouted at least as soon as did the Triumph potatoes.

Potatoes of both varieties can be kept through the summer in common storage, if handled properly. Potatoes of the Katahdin variety kept better than did those of the Triumph variety. If a place of storage is available Katahdin potatoes can be kept in sufficient quantity to compete on local markets with potatoes shipped in from other states. Potatoes can be kept for home use, from the spring crop, until well into the fall. They should be kept in as cool a place as possible, where there is good ventilation and not enough light to cause greening and where they are protected from rodents and, if possible, flies.

In Table 7 is given the moisture contents of potatoes at digging time and after removal from common storage. In general Katahdin potatoes tend to be lower in moisture than those of the Triumph variety, but this is not always true as is shown in the table. Even when Katahdin potatoes had a higher moisture content than the Triumph potatoes they kept better. No very great change in moisture content took place during storage period.

FALL GROWN POTATOES FOR SEED

Procedure

Seed for fall planting was grown from northern certified seed in the spring previous to planting. The field was rogued during the growing season for virus diseases. For seed No. 2 size potatoes were kept in common storage and planted about September 1. The plants were usually killed by frost and the tubers were dug the latter part of November. About one week after digging they were placed in storage rooms at constant temperatures of 60°, 70°, 75°, and 80° F. respectively. They were kept at these temperatures for about two months or until early February when they were removed and cut in 1½ ounce size seed pieces and planted in comparison with northern certified seed and with seed that had been kept in commercial 40° F. storage from digging time in the spring until a week before planting time in the next February. The potatoes were planted in a randomized block. Plots were 4 by 40 feet and there were five plots for each treatment. A uniform fertilizer treatment of 800 pounds of 4-12-4 was given. A top dressing of 160 pounds of ammonium sulphate was applied in 1941 and 1942, but no nitrogen could be obtained in 1943 for top dressing. Due to a very dry season and lack of top dressing the yields were low in 1943.

Experimental Results

Yield data for three years are given in Table 8. The results show that fall grown potatoes when kept at 80° F. for about two months produced yields as high as did northern certified seed. In the case of the Triumph variety there was no significant difference in yield between seed potatoes kept at 75° or 80° F. storage temperatures. The results show clearly that Irish potatoes grown in the fall can, if stored about two months at relatively high storage temperatures, be used as seed and will produce a crop comparable to that grown from northern certified seed. The fall seed kept at 80° F. sprouted as quickly when planted as did certified seed and matured its crop as early.

The data is Table 8 also show that Katahdin potatoes kept in cold storage produced good yields, as good as Triumph potatoes from northern certified seed, but not as good as new certified Katahdin seed or fall grown seed stored at 80° F. Again the yields from spring Triumph potatoes were poor.

Discussion

In spite of their relatively high moisture content Louisiana spring grown Irish potatoes can be easily kept in cold storage until time to plant the next spring's crop. If potatoes are to be placed in cold storage there should be a period of from one to two weeks before this is done. During this period the potatoes should be kept under conditions favorable for healing of wounds and suberization of the skins. This period may be compared with the curing period of sweet potatoes except the temperature should be as nearly as possible 65° to 70° F. for Irish potatoes instead of 80° to 85° F. for sweet potatoes. The period of greatest physiological shrinkage will be during this period.

Even though potatoes can be kept satisfactorily in cold storage, the results that have been obtained will not warrant the recommendation that Louisiana spring grown Triumph Irish potatoes be kept for planting the next spring's crop. The yields of the cold storage Triumph seed were low and this was due to early maturity of potatoes, which seemed to be correlated with the length of the dormant period. Limited results with several other varieties of potatoes were similar to those obtained with the Triumph variety, but potatoes of the Katahdin variety were an exception. Results with the Katahdin variety indicate that it can be recommended, when it is economically advantageous, that potatoes of this variety be kept in cold storage for seed purposes. This has been done successfully for several years. The Katahdin variety is resistant to some of the potato diseases, but fields to be used for seed should be rogued as carefully as possible. It would be safer to get new certified seed at least every few years. The fact that Katahdin potatoes can be successfully stored from the spring crop for seed for the next spring crop is encouraging to the plant breeder. An Irish potato breeding program has been under way in the South now for several years and it is not too much to hope that soon varieties better adapted to this sec-

Table 8. Effect of Temperature of Storage of Fall Grown Seed Potatoes on Yields Produced Compared with Northern Certified Seed and Cold Storage Potatoes Kept from the Spring Crop.

Variety	Type of seed	1941			1942			1943			3 yr. average		
		No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
Katahdin	Northern certified	209.5	8.9	2.2	166.6	18.4	7.2	113.5	17.1	3.3	162.3	14.6	4.2
Katahdin	Cold storage (spring grown)	178.8	24.3	4.8	117.1	29.2	11.5	116.4	12.2	2.1	137.4	31.9	6.1
Katahdin	Fall 60° F.	102.9	8.5	3.2	71.7	10.2	4.8	100.3	8.7	1.5	91.6	9.6	3.2
Katahdin	Fall 70° F.	154.7	9.9	2.4	103.8	11.1	4.5	116.2	10.2	2.6	124.6	10.4	3.2
Katahdin	Fall 75° F.	172.3	8.8	1.7	119.1	11.4	5.5	116.9	9.9	1.4	136.1	10.0	2.9
Katahdin	Fall 80° F.	207.6	8.3	1.9	171.2	13.7	7.1	119.5	10.3	2.7	166.1	10.8	3.9
Triumph	Northern certified	160.1	17.4	3.9	144.6	39.0	19.3	98.6	25.7	4.7	134.3	27.4	9.3
Triumph	Cold storage (spring grown)	112.6	48.3	4.8	28.8	15.1	11.2	67.6	17.8	3.3	69.7	27.1	6.4
Triumph	Fall 60° F.	189.6	9.6	2.3	68.2	21.2	12.8	109.0	19.5	3.4	122.3	16.8	6.2
Triumph	Fall 70° F.	187.0	12.5	3.1	82.1	22.2	15.4	99.0	23.0	4.4	122.7	19.9	7.6
Triumph	Fall 75° F.	208.7	10.7	3.0	105.7	22.6	14.1	110.8	21.8	4.0	141.7	18.7	7.0
Triumph	Fall 80° F.	190.7	9.3	1.7	143.1	27.8	16.3	98.6	20.7	3.4	144.1	19.3	7.1

tion will be developed. It is possible that a good seedling that is even better than the Katahdin as a home grown seed potato to be kept in cold storage may be found.

Spring grown potatoes grown in southern Louisiana can be successfully kept in common storage through the summer in the locality in which they are grown. More of the crop should be kept this way. This is especially true in war time due to the crowded condition of the transportation facilities. The Katahdin potatoes keep better than those of the Triumph variety and are more highly recommended for summer storage. If no Katahdin potatoes have been grown, some of the Triumph variety should be kept.

In general a storage temperature of 80° F. would be considered much too high for the storage of Irish potatoes. It proved, however, to be excellent for fall grown Irish potatoes that were to be used for seed purposes for the spring crop. Unless fall grown potatoes are kept at high storage temperatures they sprout late when used for seed and the crop produced is late and unless conditions are good late in the season the yields produced are light. When kept at high temperatures fall potatoes as seed compared very favorably with northern certified seed. There are two main difficulties with this source of seed. One is the difficulty of producing a fall crop. The other is having a storage place that will maintain a high temperature during December and January. Some fall produced potatoes are used for seed every year and the results seem to justify making every effort to store them at effectively high temperatures. In some areas this could be a cooperative effort.

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LOUISIANA BULLETIN NO. 387 OCTOBER, 1944

Wintering Beef Cows in the Rice Area

By

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IN COOPERATION WITH SWIFT AND CO.,
LAKE CHARLES, LA.

Lot 7. Cows wintered on rice straw, concentrates, salt, and di-sodium phosphate.

LOUISIANA STATE UNIVERSITY

AND

AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS
W. G. TAGGART, *Director*

SUMMARY

1. Supplementing rice straw and pasture with 3 pounds of mixed rice products and cottonseed meal for 90 to 112 days reduced death losses from 5.7% to a minimum of 1.04%, increased the percentage calf crop 6.3% per 100 cows and produced calves earlier in the spring. The value of additional beef produced, together with the decreased death loss was estimated at about $6.50 to $7.50 per cow in comparison to $3.67 expended for supplementary feed.

2. The feeding of concentrates to cows in winter increased the birth weight of calves about 5 pounds per calf, and produced calves weighing 18 lbs. heavier at weaning time.

3. With reasonably adequate winter management and controlled breeding methods, the cows in the rice-straw group averaged a 66.6% calf crop, and the rice-straw-concentrate cows averaged a 72.9% calf crop. With better shelter and a selected herd of cattle the calf crop should be at least 85%.

4. Strong, mature cows wintered on rice straw on good, native grass pasture alone, may go through the winter in normal condition and raise good calves without extra feeding. The weaker and older cows, or the young heifers with calves are most likely to suffer from shortage of feed during cold weather and should receive additional care. But the stronger cattle will also benefit from feeding by earlier breeding, producing larger calf crops, and reduction in death losses.

5. Apparently no benefits resulted in this area from feeding minerals, other than salt. This does not mean that mineral supplements are not needed in other parts of the state, particularly in the upland sections or in other parts of the coastal area.

Wintering Beef Cows in the Rice Area

By

M. G. Snell, C. I. Bray, F. L. Morrison, Murl Jackson, and A. S. Gates
in cooperation with Swift and Co., Lake Charles, La.

In 1938 Swift and Co. of Chicago located a branch packing plant near Lake Charles, Louisiana, on an old rice farm of approximately five hundred (500) acres, 400 acres of which was offered to the Louisiana State Agricultural Experiment Station for cooperative live stock and pasture experiments. One of the original projects begun in 1939 dealt with the question of wintering rations, and mineral supplements for beef cows in the rice area. The object was to determine the effect of winter feeding and mineral supplements on calf production, winter gains of cows, and the reduction of winter losses.

The leading cattle parishes in the state are in a large measure the parishes in which the largest amount of rice is grown. Rice growing and cattle production go well together. Rice is not usually grown on the same land year after year, but in rotation with pasture. A common system of management is to grow rice one year and then allow the land to lie fallow one or two years as pasture. One reason for pasturing fallow rice land is to eliminate red rice. Another reason for maintaining cattle in this area is the utilization of rice straw, rice stubble and second-growth rice. There is also considerable grass land, not in cultivation, available for grazing. The winter climate is mild, due to the proximity of the Gulf, and cattle run out the year round, with only natural shelter and with little extra feed.

This experiment was planned in 1938 by Dr. M. G. Snell, Associate Animal Husbandman, in cooperation with Swift and Company of Lake Charles, Louisiana. The land and cattle for the experiment were furnished by Swift and Company. The work was in immediate charge of Mr. F. L. Morrison, Research Assistant. Dr. Snell, a captain in the Officers Corps, was called into the service in February 1941. In November 1941, as a Major in the Armored Division, he was stationed in the Philippines and became a prisoner of war after the fall of Bataan. F. L. Morrison was given military leave in November 1940, and was succeeded by Murl Jackson who was called for military service in June 1942. C. I. Bray, the author, assumed charge of the work from the fall of 1941 until the close of the test in October 1942. Mrs. Aldina S. Gates, a graduate student in Animal Industry, rendered much valuable assistance in assembling and tabulating the experimental records and writing up much of the original material, which was presented as a graduate thesis, WINTERING COWS IN THE RICE AREA, in partial fulfillment of the requirements for the degree of Master of Science. Dale Taggart succeeded Murl Jackson as herdsman and did good work in caring for the herd and keeping records of feeds and calving dates in 1941-42.

Due to changes in personnel during the experiment and the absence of those originally in charge, it is probable that some items of information may have been omitted. The report as given summarizes all the data available to the present authors.

The Louisiana Experiment Station and the cattlemen of Louisiana are indebted to Swift and Co. for providing the land and cattle which made this experimental work possible, and for the continued cooperation of the officials of the company at the Lake Charles branch, particularly John M. Powell, former manager of the plant, V. A. Gilpin, present manager, and Robert T. Harper, Supt. of the Swift & Co. Stockyards.

While some of the best beef herds in the state are found in the rice section, and advanced methods of management are followed by many stockmen, the cattle industry in this area is frequently looked upon only as a byproduct of rice farming, with little attention paid to better breeding or good management. The percentage calf crop in such herds is usually low and the cattle are of low quality. There is too often a lack of sufficient pasturage and adequate winter feed. It is believed that by better management and good breeding, cattle raising in the rice area could make a more important contribution to farm income.

PLAN OF EXPERIMENT

Ninety-six (96) cows of common mixed breeding, typical of many of the cattle in this section of the state, were purchased on the open market in the fall of 1938 and divided into eight lots of 12 cows each. It might be judged from the high percentage calf crop in 1939 that only cows that appeared likely to drop calves were selected for the test. Each herd of 12 cows had a native grass pasture of 40 acres, principally carpet grass and Bermuda with a considerable amount of sedge grass. One group, Lots 1 to 4, was wintered on rice straw and pasture only. The other group, Lots 5 to 8, was wintered on rice straw and pasture with 3 pounds of concentrates daily per head for a period not exceeding 112 days each winter, usually beginning in December and ending in March. The concentrate ration was made up of 9 parts rice bran, 3 parts rice polish, and 4 parts cottonseed meal.

The minerals fed in this experiment were as follows:

Group I Rice Straw Only With Pasture		**Group II** Rice Straw and Concentrates With Pasture	
Lot		Lot	
1	Salt only	5	Salt only
2	Salt 75% Ground oystershell 25%	6	Salt 75% Ground oystershell 25%
3	Salt 75% Di-sodium phosphate 25%	7	Salt 75% Di-sodium phosphate 25%
4	Salt 50% Ground oystershell 25% Di-sodium phosphate 25% or Salt 75% Bone meal 25% With bone meal in addition	8	Salt 50% Ground oystershell 25% Di-sodium phosphate 25% or Salt 75% Bone meal 25% With bone meal in addition

The mineral supplement for Lots 4 and 8 was changed in 1940 to 75% salt and 25% bone meal, and later to 50% salt and 50% bone meal, with bone meal also fed separately.

As no natural shelter was available, cheap shelters were constructed, with corrugated iron sheeting on the north side only, and an overhead cover of woven wire and rice straw for summer shade.

Four Aberdeen-Angus bulls were supplied by Swift and Company for breeding these cows. As the two pastures for cows receiving similar mineral supplements were opposite each other across a dividing lane, the plan was for the bulls to be moved across the lane from one group to the other each two or three days, or more often if necessary. With close supervision, such a plan would be effective; otherwise it would not. The relatively good calf crop of 1942 indicates that this method of breeding worked satisfactorily in 1941, but may not have been as successful in the two preceding years. The bulls were separated from the herds during the winter and fed until approximately May 1. It was first planned to keep the Aberdeen-Angus grade heifer calves to build up a permanent breeding herd, but for various reasons it was found advisable to sell all calves at the end of each summer.

WEIGHING

The cows and calves were usually weighed at intervals of approximately 28 days. Weigh days were made to correspond with the beginning and end of winter feeding, also the time of weaning of calves in the fall. Weights were taken of calves at birth and the weights and date of birth recorded.

DEATH LOSSES AND REPLACEMENTS

Until 1942, when cows died, or were slaughtered on account of poor condition, they were replaced by other cows from the local yards. Usually cows were selected that appeared to be in calf, though a few were not. In most of the tables following, these replacement cows have been omitted in making up the averages.

AMOUNTS OF FEED CONSUMED

The amounts of concentrates fed were 232 pounds per head in 1939, 336 pounds per head in 1939-40 and in 1940-41, and 276 pounds per head in 1941-42. The amounts of rice straw eaten ranged from 1158 pounds to 1340 pounds per head in 1939-40, from 840 to 932 pounds per head in 1940-41, and from 379 to 421 pounds in 1941-42. The 1942 feeding season was shorter than the two previous years, and the rice straw was probably not of as good quality. In the first year of the test feeding began in January and less feed was consumed. There was slightly better grazing the last year of the test. In the second year of the test (1939-40) straw feeding continued for a longer period of time than in following years. There did not seem to be any difference between the two groups in amount of straw eaten.

The following pages give the record of weights, death losses, and calving records for the eight lots of cows. Also the rations and mineral mixtures fed in each lot.

Lot. 1. Cows wintered on rice straw and salt only. Picture taken at the close of winter feeding period, April 2, 1942.

TABLE I—Record of Weights and Calves

Lot 1. Rice Straw — Salt Only

	Weights			Calving Record			
Cow No.	Jan. 1939	Oct. 1942	Gain or Loss	1939	1940	1941	1942
1	707	840	133	C	—	C	C
10	565	790	225	C	C	—	C
15+	673			C			
17	793	890	97	C	C	C	C
19*	677	630	-47	—	C	C	C
23	690	970	280	C	C	C	—
43	598	740	142	C	C	—	C
52	515	815	300	C	—	C	C
58	612	740	128	C	C	C	C
80	748	835	87	C	—	C	C
81	575	880	305	—	C	—	—
87	553	955	402	—	C	C	—
91	582	845	263	C	—	C	—
Total 12	7615	9930	2315	10	8	9	8
Average	634.6	827.5	192.9				

+15 No record after 1939 — Not included in weight average.
*19 Transferred from Lot 2, 1939.
Calves dropped 35. Percentage calf crop — 72.9%.
Loss — one cow, No. 15; no record — not included as loss.

Lot 2. Cows wintered on rice straw, ground oystershell, and salt. Picture taken in May.

TABLE II—RECORD OF WEIGHTS AND CALVES

Lot 2. Rice Straw — Salt — Oystershell

		Weights			Calving Record			
	Cow No.	Jan. 1939	Oct. 1942	Gain or Loss	1939	1940	1941	1942
	9	795	805	10	C	C	—	C
	31	695	680	-15	C	C	—	C
	42+	710			C	C		
	45++	698			C	—	C	
	46	508	775	267	C	—	C	C
	59	570	910	340	—	C	C	—
	69	600	790	190	C	—	C	C
	76*	695			C	—	—	
	83	610	730	120	C	C	—	C
	88	558	615	57	C	C	—	C
	94	573	795	222	—	C	C	C
	98**	670	855	185		—	C	—
	104†		955					C
	109††		680					C
Total	9	5579	6955	1376	9	7	6	9
Average		619.9	772.8	152.9				

+42 Died February 16, 1941.
++45 Slaughtered November, 1941.
*76 Slaughtered March, 1942.
**98 Put in Oct. 1939 — Weight 670 — Weights considered in totals.
†104 Put in May 1941 — Weights not considered.
††109 put in February 1942 — Weights not considered.
Calves dropped 31. Percentage calf crop — 68.2%.
Dead or slaughtered — 3.

Lot 3. Cows wintered on rice straw, Di-calcium phosphate and salt. Picture taken April 2, 1942.

TABLE III—Record of Weights and Calves

Lot 3. Rice Straw — Salt — Di-calcium Phosphate

	Weights			Calving Record			
Cow No.	Jan. 1939	Oct. 1942	Gain or Loss	1939	1940	1941	1942
7	560	745	185	C	—	C	—
12	692	850	158	C	—	—	C
26	637	740	103	C	C	—	C
47	568	780	212	—	C	—	C
53	653	835	182	C	—	—	C
55*	620			C	—	C	
62	697	805	108	C	—	C	C
70	812	715	-97	C	C	—	C
73*	495			C	C	C	
75+	550			—	C		
89	668	820	152	C	—	C	—
90*	642			C	C	—	
106†		695					
107†		555					C
108†		780					
Total 8	5287	6290	1003	10	6	5	7
Average	660.8	786.2	125.4				

*55, 73, 90 Slaughtered November 1941.
+75 Died November 1941.
†107, 106, 108 Put in Jan. 1942 — Not included in weights.
†106, 108 Not included in list of cows calving.
Calves dropped 27. Percentage calf crop — 61.4%.
Death loss — 1 died — 3 culled out.

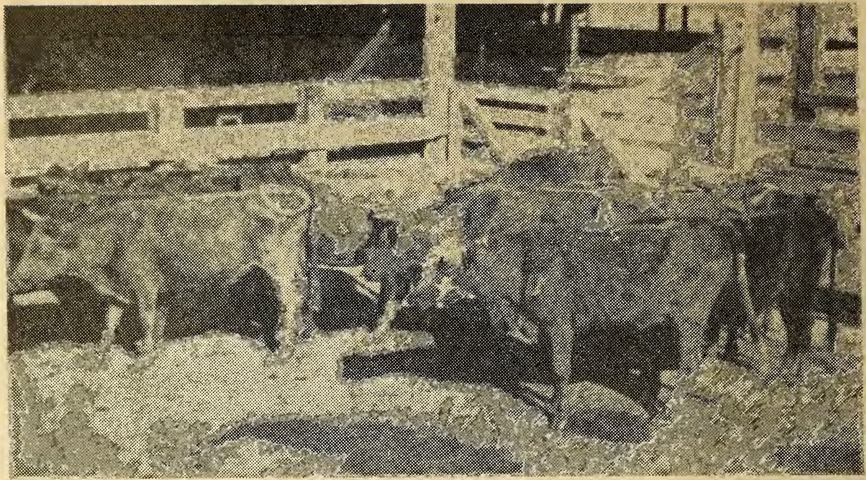
Lot 4. Cows wintered on rice straw, salt and bone meal. Picture taken April 2, 1942.

TABLE IV—RECORD OF WEIGHTS AND CALVES

Lot 4. Rice Straw — Salt — Bone Meal

	Weights				Calving Record			
Cow No.	Jan. 1939	Oct. 1942	Gain or Loss		1939	1940	1941	1942
4*					C			
6	690	850	160		C	—	C	—
21	640	750	110		C	C	—	C
24	617	715	98		C	C	—	C
38	642	890	248		C	—	—	—
48	615	780	165		C	—	C	—
57	602	635	33		C	—	C	C
61	565	730	165		C	—	—	C
63	603	875	272		C	—	—	C
66	490	750	260		C	C	—	C
74	735	845	110		C	C	—	C
95†					C			
97**								
99**								
100+								C
101+								C
Total 10	6199	7820	1621		12	4	3	9
Average	619.9	782.0	162.1					

*4 Died June 24, 1939.
**97, 99 Put in 1939 — Died Feb. 1940.
†95 Taken out 1939.
+100, 101 Put in April 1940 — Weights not included.
Calves dropped 28. Percentage calf crop — 63.6%.
Death loss — 3 died — 1 taken out.



Lot 5. Cows wintered on rice straw, concentrates, and salt. Picture taken April 2, 1942.

TABLE V—Record of Weights and Calves

Lot 5. Rice Straw — Concentrates — Salt

	Weights			Calving Record			
Cow No.	Jan. 1939	Oct. 1942	Gain or Loss	1939	1940	1941	1942
5	687	640	-47	C	C	—	C
13	573	770	197	C	—	C	C
16	532	755	223	C	C	C	C
18	722	880	158	C	C	C	C
22	630	705	75	C	C	C	—
29*	593	805	212	C	C	C	—
30	775	985	210	C	C	—	C
44	677	815	138	C	C	C	C
67	640	675	35	C	C	C	C
78	492	625	133	C	—	C	C
79	533	810	277	C	—	C	C
93	720	740	20	C	—	C	C
Total 12	7574	9205	1631	12	8	10	10
Average	631.2	767.1	135.9				

*29 Sold June 26, 1942 — Included in final weights.
Calves dropped 40. Percentage calf crop — 83.3%.
Death loss — None.

Lot 6. Cows wintered on rice straw, concentrates, salt, and oystershell. Picture taken April 2, 1942.

TABLE VI—Record of Weights and Calves

Lot 6. Rice Straw — Concentrates — Salt — Oystershell

		Weights				Calving Record			
	Cow No.	Jan. 1939	Oct. 1942	Gain or Loss		1939	1940	1941	1942
	11	488	645	157		C	—	C	—
	14*	602				C	—	C	
	25	682	900	218		C	—	C	C
	28+	687	860	173		—	—	C	C
	35	500	855	355		—	C	C	—
	36	812	1065	253		C	—	C	—
	37	623	790	167		C	—	C	C
	39	575	740	165		C	—	C	C
	49	820	905	85		C	—	C	C
	68	618	740	122		C	—	C	C
	71	647	750	103		C	C	—	C
	85	602	875	273		C	—	C	—
Total	11	7054	9125	2071		10	2	11	7
Average		641.3	829.6	188.3					

*14 Slaughtered in poor condition Feb. 1942.
+28 Killed by lightning after calving 1942 — Weight included.
Calves dropped 30. Percentage calf crop — 63.8%.
Death loss — 1 killed by lightning — not included in deaths.
1 slaughtered.

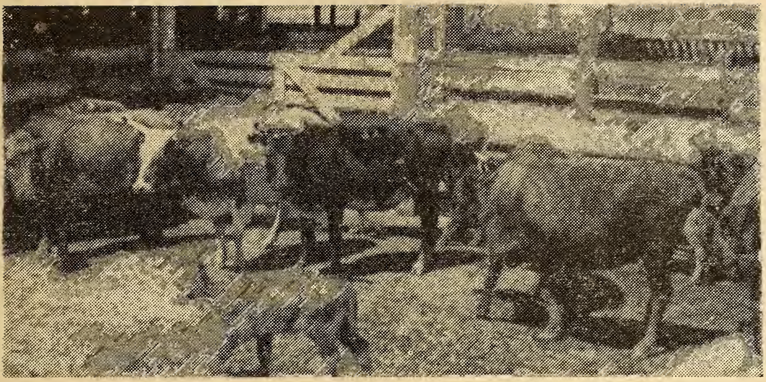
Grade Angus calves produced from common cows. Lot 7 had a perfect calf crop in 1942. Picture taken in late summer.

TABLE VII—RECORD OF WEIGHTS AND CALVES

Lot 7. Rice Straw — Concentrates — Salt — Di-sodium Phosphate

Weights				Calving Record			
Cow No.	Jan. 1939	Oct. 1942	Gain or Loss	1939	1940	1941	1942
2	625	860	235	C	C	—	C
8	817	810	-7	C	C	—	C
20	677	885	208	C	C	—	C
27	522	615	93	C	—	—	C
33	692	755	63	C	C	—	C
34	652	635	-17	C	—	C	C
41	598	755	157	C	—	C	C
51*	832			C	—		
54	553	780	227	—	C	—	C
60	555	720	165	C	—	C	C
77	587	785	198	C	—	—	C
84	510	695	185	C	C	—	C
105+		675					C
Total 11	6788	8295	1507	11	6	3	12
Average	617.1	754.1	137.0				

*51 Injured on weigh day — Slaughtered May, 1941.
+105 Put in June, 1941 — Weights not considered.
Calves dropped 32. Percentage calf crop — 68.1%.
Death loss — 1.



Lot 8. Wintered on rice straw, concentrates, salt, and bone meal.

TABLE VIII—Record of Weights and Calves

Lot 8. Rice Straw — Concentrates — Salt — Bone Meal

	Weights				Calving Record		
Cow No.	Jan. 1939	Oct. 1942	Gain or Loss	1939	1940	1941	1942
3*	798			C	C		
32	633	855	222	C	—	C	C
40	803	1050	247	C	C	—	—
50	533	825	292	C	—	C	C
56	650	785	135	C	C	—	C
64	615	795	180	C	C	—	C
65	692	815	123	C	C	—	C
72*	645			C	C		
82	707	725	18	C	C	—	C
86	698	705	7	C	C	—	C
92	575	780	205	C	C	—	C
96	597	795	198	C	C	C	C
102+		800					C
103+		885					—
Total 10	6503	8130	1627	12	10	3	10
Average	650.3	813.0	162.7				

*3, 72 Killed by lightning November 10, 1940.
+102, 103 Put in December, 1940. Weights not considered.
Calves dropped 35. Percentage calf crop — 76.1%.
Death loss — 2 killed by lightning.

EFFECT OF FEEDING CONCENTRATES ON SIZE OF CALF CROP

The percentage calf crop is of particular interest to the cattleman. One reason frequently given for poor financial returns from cattle in the rice area is the low percentage calf crop, generally estimated as between 40 and 60 per cent. The cows in this test produced fair calf crops, though some of the lots had an extremely poor record at least one year out of four. The cows receiving concentrates averaged a 72.9% calf crop for four years and those receiving straw only, averaged a 66.6% calf crop.

Out of 96 original cows, 7 had 4 calves in 4 years. Five of these were in the groups receiving concentrates and two in the lots fed no concentrates. Fifty-two cows had 3 calves in 4 years; 30 of these had been fed concentrates and 22 fed no concentrates. This made a total of 35 out of the 48 original cows (73%) in the concentrate group that had 3 calves or more, and 24 out of 48 (50%) that had 3 calves or more in the lots fed no concentrates. Lot 5, fed rice straw, concentrates, and salt, had the best production record, with an 83.2% calf crop and no cows dead or discarded, 4 cows with 4 calves each, and no cows with less than 3 calves.

Cows having only one or two calves were usually on experiment only part time. The two cows killed by lightning in 1940 each had two calves in two years. Table X gives the calving record of the cows on the experiment full time and shows the number of cows with 4

TABLE IX—Calves Dropped in Four Years 1939-1942

Includes All Cows on Test During Four Years

Cows Fed No Concentrates

Lot No.	1	2	3	4		
Mineral	Salt Only	Salt Oyster shell	Salt Phosphate	Salt Bone meal		Total or Average
Calves dropped	35	31	28	28		122
Possible no. of calves	48	45	44	46		183
Per cent calves	72.9	68.8	63.4	60.8		66.6

Cows Fed Concentrates

Lot No.	1	2	3	4		
Mineral	Salt Only	Salt Oyster shell	Salt Phosphate	Salt Bone meal		Total or Average
Calves dropped	40	30	32	35		137
Possible no. of calves	48	47	47	46		188
Per cent calves	83.3	63.8	68.1	76.1		72.9

calves, 3 calves, 2 calves, or 1 calf in the various lots. The lots fed concentrates in winter showed no cows with less than 2 calves in 4 years. In Lot 8, fed concentrates and bone meal, the only cow with less than 3 calves was a rather fat cow that dropped 2 calves the first 2 years and then probably became too fat to breed. It is possible that the bulls used in Lots 3 and 4, and in Lots 7 and 8 may not have been sure breeders to judge by the poor calf crops in these lots in 1940-41. In 1941, Lots 3 and 7 bred to the same bull had only a 37% calf crop, while Lots 4 and 8 bred to the same bull had only a 25% calf crop. Lot 6 also had a poor calf crop in 1940. There was no record as to which bulls were used in each lot in any particular year. Lots 7 and 8 had excellent calf crops in 1942.

TABLE X—Calving Record of Cows Completing 4 Years Grazing Seasons on Test 1939-1942*

	Fed Straw Only				Fed Straw and Concentrates			
Lot No.	1	2	3	4	5	6	7	8
Mineral	Salt Only	Salt Oyster shell	Salt Phosphate	Salt Bone meal	Salt Only	Salt Oyster shell	Salt Phos. phate	Salt Bone meal
Total Cows Counted	12	9	8	10	12	11	11	10
Cows with 4 calves	2	0	0	0	4	0	0	1
Cows with 3 calves	7	7	3	5	8	6	8	8
Cows with 2 calves	2	1	5	4	0	5	3	1
Cows with 1 calf	1	1	0	1	0	0	0	0

* A few dry cows were sold in midsummer 1942.

EFFECT OF CONCENTRATE FEEDING ON DEATH LOSSES

The feeding of concentrates appeared to be very effective in reducing death losses. Of the four lots fed concentrates in winter only one cow died from natural causes in 4 years, with one other cow reported as slaughtered after being injured during weighing. This is practically 1% (1.04%) death loss per year, counting both cows. Three cows in this group were struck by lightning; two in 1940 and one in 1942. These are not included from the experimental viewpoint in calculating death losses. In the group receiving no concentrates (Lots 1-2-3-4) there was a heavier death loss. In Lot 1 (salt only) there is no record of one cow after the first year, but this has not been included as a death loss. In Lot 2 (salt and oystershell) two cows were slaughtered in poor condition, one in 1941 and one in 1942. In Lot 3 (salt and phosphate) one cow died and three were slaughtered in poor condition in 1941. In Lot 4 (salt and bone meal) one cow died, one cow was removed in poor condition in 1939, and 2 replacement cows died in 1940, making a total of 10 cows out of 48 that either died or were slaughtered, making a loss of 23% in four years or 5.7% loss per year.

View of cows on native pasture used in the experiment showing type of shelter.

EFFECT OF CONCENTRATE FEEDING ON WEIGHTS AND GAINS OF COWS

Feeding concentrates did not appear to have any permanent effect on the live-weights of cows over the 4 year period. There might have been a difference in favor of the cows fed concentrates had there been as large a proportion of dry cows in the concentrate fed lots in 1942 as in the lots on straw only. According to the weight records of all cows that went through the 4-year period or until mid-summer of 1942, the cows fed no concentrates made a total average gain of 162 pounds or 40.5 pounds per year, and those fed concentrates gained 155 pounds or about 39 pounds per year. With few exceptions, all cows gained the first winter. After the first winter, the cows not receiving concentrates usually lost, on the average, 18 pounds more than the fed cows during the winter feeding period, but gained back 19 pounds more than the others during the remainder of the year. Cows raising calves usually lost a little weight during the year, after 1939, while dry cows averaged about 120 pounds gain per year. Of the cows that raised calves in 1942, those in Lots 1 to 4, receiving no concentrates, gained 130.9 pounds per head during the four years. Those in Lots 5 to 8, receiving concentrates, gained 140.2 pounds per head in the four years. Of the cows which were dry in 1942, at the end of the experiment, the 12 straw fed cows had made an average gain of 233 lbs. as compared to 194 lbs. average gain for 8 dry cows in the straw and concentrate group. This unusual showing for the straw fed dry cows seems to be largely due to a gain of 312 lbs. each for the 4 dry cows in Lot 1.

Effect of Concentrates and Mineral Feeding on Average Annual Gain of All Cows on Test Four Years

Table XI

Total Cows, Cows With Calves, and Dry Periods.

A. GROUP FED STRAW ONLY

Lot No.	Mineral Mixtures	Total Cows				Cows With Calves		Dry Periods	
		Number of cows remaining 4 years	Total cow-years	Average gain in 4 years Lbs.	Average gain per year Lbs.	Number of Calves	Gain or Loss Lbs.	Number of Dry Periods	Gain or Loss Lbs.
1	Salt Only	12	48	192.9	49	34	22.2	14	111.5
2	Salt Oystershell	9	36	152.9	38.1	24	-13.6	12	141.8
3	Salt Phosphate	8	32	125.4	31.2	19	-62.6	13	168.6
4	Salt Bone Meal	10	40	162.1	40.5	27	24.1	13	74.6
	Total or Average	39	156	161.9	40.4	104	-1.06	52	123.5

B. GROUP FED CONCENTRATES AND RICE STRAW

Lot No.	Mineral Mixtures	Total Cows				Cows With Calves		Dry Periods	
		Number of cows remaining 4 years	Total cow-years	Average gain in 4 years Lbs.	Average gain per year Lbs.	Number of Calves	Gain or Loss Lbs.	Number of Dry Periods	Gain or Loss Lbs.
5	Salt Only	12	48	135.9	34.4	40	20.6	8	100.6
6	Salt Oystershell	11	44	188.3	47.1	28	-25.1	16	173.3
7	Salt Phosphate	11	44	137.0	34.2	30	-27.0	14	169.7
8	Salt Bone Meal	10	40	162.7	40.8	30	6.2	10	144.0
	Total or Average	44	176	155.4	38.9	128	-4.4	48	154.0

In the above table each year for each cow is considered separately, making four cow-years for each cow. The final weights for each year were taken at weaning time A few dry cows were sold in June of the final year, 1942.

Table XI is a record of weights and gains based on individual 12 month records of cows raising calves as compared to dry cows. Only cows going through 3 or more years of the test are included. The table covers 332 cow-years (number of cows x no. of years). Two hundred and thirty-two of these cow-years are of cows raising calves and 100 are of cows not raising calves. In the first 4 lots, fed straw only, cows raising calves averaged 1.06 pounds loss per year as compared to an average loss of 4.14 pounds for those receiving concentrates. Dry cows, on straw alone, averaged 123.5 pounds gain per year, and dry cows on straw and concentrates averaged 154 pounds gain per year.

EFFECT OF CONCENTRATE FEEDING ON TIME OF BREEDING, BIRTH WEIGHT OF CALVES AND GROWTH OF CALVES

Not a great deal of difference can be shown in regard to the effect of supplementary feeding on early calf crop. Table XII gives the percent calf crop, average age, average gain, and rate of gain for the last three years of the test. In 1942 the calves in the concentrate fed lots averaged 18½ days earlier than the calves in the other lots, and made on the average 7.5% faster gains. In 1941 the calves from the straw fed lots averaged 4 pounds less at birth but for some reason made more rapid gains up to weaning time. In 1940 there was a difference of over 5 pounds in birth weight in favor of concentrate feeding, and the calves made more rapid gains. The average for the three years showed 8 days earlier calving, 4.8 pounds heavier calves at birth, and an increased rate of gain of calves from the concentrate fed cows.

Intervals Between Calves

For cows having calves two or three years in succession the interval between calves was about 13 months for the concentrate fed lots and 13½ months for the lots on straw alone. Cows missing a year averaged about 22 months between calves in either group. Of the cows calving in June, July, or August only about ⅓ brought calves the following year. Had the bulls run with the herd all the year round these cows would probably have produced fall calves. Of the cows raising four calves in four years the average interval was 11 to 12 months between calves for the concentrate fed group, and 12½ to 13 months between calves for the two in the straw fed group.

Death Losses in Calves

The death losses among calves was very low. So far as known there were no abortions. Two young calves were reported missing in 1942, and one large calf died suddenly in Lot 5, the same year. An autopsy failed to show the cause of death.

Table XII Calf Crop from Cows Wintered on Rice Straw and Pasture and from Cows Wintered on Rice Straw, Pasture and Concentrates. Effect on Early Calving, Birth Weights, and Rate of Gain

Lot Number	Number of Calves	Percentage Calf Crop	Average Age Days at Weaning	Average Birth Weight Lbs.	Average Weaning Weight Lbs.	Average Gain Lbs.	Average Daily Gain, Lbs.
1940							
Straw fed lots 1 — 4	21	53.0	144.8	61.2	259	197.8	1.366
Straw and Concentrates 5 — 8	24	53.3	136.0	66.4	267	200.6	1.474
1941							
Straw fed lots 1 — 4	19	48.7	168.0	65.0	304	239.0	1.420
Straw and Concentrates 5 — 8	27	60.0	171.6	69.0	290	221.0	1.267
1942							
Straw fed lots 1 — 4	28	71.7	170.8	65.2	258	192.8	1.128
Straw and Concentrates 5 — 8	35*	82.2	189.2	67.8	296	228.2	1.205
Three-Year Average 1940-1942							
Straw fed lots 1 — 4	23	58.9	162.0	63.9	271.1	207.2	1.278
Straw and Concentrates 5 — 8	29	65.1	170.6	68.7	289	220.3	1.293

NOTE: Above records are on calves from cows retained in the experiment all four years. 1939 calf crop not included.

* 37 calves dropped, one calf missing and one calf died.

MINERAL FEEDING

In this test, the feeding of mineral supplements did not appear to be of any particular benefit, and might even appear to have had a detrimental effect rather than otherwise. This does not mean that mineral supplements are not necessary in other parts of the state, particularly in the upland sections. Evidently there was no particular need for extra calcium (lime) or phosphorous for beef cows in this area. The consumption of salt and minerals in this experiment was low, which may be sufficient evidence that the cows were not in serious need of calcium or phosphorous supplements. The following table gives the average amount of minerals consumed during two 12-month periods of the test, 1940-41 and 1941-42.

Table XIII. MINERAL CONSUMPTION — 1940-41—1941-42*

Cows Not Fed Concentrates

	Lbs. Per Month						Grams Per Day		
Lot	Total Lbs. Consumed	Salt	Oyster-shell	Di-Sodium Phosphate	Bone Meal		Salt	Calcium	Phosphate
1	.58	.58					8.77		
2	.38	.285	.095				4.31	.575	
3	1.08	.81		.27			12.26		.351
4	1.17	.878			.292		13.28	4.125	1.933
	.56+				.56				

Cows Fed Concentrates

	Lbs. Per Month						Grams Per Day		
Lot	Total Lbs. Consumed	Salt	Oyster-shell	Di-Sodium Phosphate	Bone Meal		Salt	Calcium	Phosphate
5	.506	.506					7.66		
6	.43	.323	.107				4.88	.647	
7	.72	.54		.18			8.17		.234
8	.933	.70			.233		10.59	4.324	2.027
	.66+				.66				

*Spring 1940 to Spring 1941, and Fall 1941 to Fall 1942.
+Bone meal alone.

Since the consumption of mineral matter was low, it is questionable whether any conclusions can be drawn in regard to any possible adverse effects of mineral feeding. The cows receiving minerals did not produce as high a percentage of calves as did the lots receiving salt alone. There were also more death losses in the lots receiving minerals than in the lots on salt alone. The lower calf crops in Lots 2 and 3 and Lots 6 and 7 might have been due to the use of bulls that were not satisfactory breeders. This would not explain, however, the heavier death losses in these lots compared to those on salt alone. Since the same minerals used in this test have been consumed in much larger amounts by cattle in other places, without adverse results, it may be supposed that the higher percent of death losses in the mineral fed lots were due to chance or to other causes than mineral feeding, unless future tests should prove otherwise.

The conclusions from this and from a previous experiment conducted at Crowley* is that good feeding is of greater importance in preventing death loss in this area than is the feeding of mineral supplements, unless a mineral deficiency is clearly evident. The requirements for minerals in this area is deserving of further investigation.

APPLICATION OF EXPERIMENTAL RESULTS TO FARM PRACTICE

Wintering Methods in Louisiana

In Louisiana, grade beef cattle are very rarely kept up and fed in winter, as is done in the north, but normally run out on pasture or woodlands, or in stalk fields, or stubble fields with little supplementary feed other than cheap roughage such as straw, or rough hay, with sometimes a limited amount of concentrates. The amount of supplementary feed supplied depends entirely on the amount of natural forage available, the severity of the winter, and the condition of the cattle in fall and early winter. In South Louisiana some green grass may be found almost any time during the winter months. In some years white clover will be found in bloom in January or February, but on the other hand there may be killing frosts as late as March, enough to temporarily kill all green growth. In normal years, beef cattle with fair pasture will eat no hay or straw after the tenth to the fifteenth of March. However, if cattle are in very poor condition in March, a hard freeze or sleet storm may result in heavy death losses unless extra feed is supplied.

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* In 1935-37 Snell conducted an experiment in wintering beef cows on the farm of Chester Hyde near Crowley, Louisiana, to determine the effect of winter feeding, mineral supplements, and rye grass pasture on the weights, mortality, and calf production of cows wintered principally on rice straw. Seventy cows were divided into five lots, from 11 to 16 cows each, and wintered as follows:

Lots I to IV were grazed on rice stubble and fed stacked rice straw and salt. Lot I received no other feed. Lot II received a mineral mixture of two parts of bone meal and one part salt. From December 19 to April 23, the cows in Lot III received a feed mixture nine parts rice bran, three parts rice polish, and four parts cottonseed meal, 3 pounds daily, but no minerals other than salt. Lot IV received the same feed mixture as Lot III and the same mineral mixture as Lot II. Lot V was wintered on a rice stubble field seeded with Italian rye grass, with mineral mixture and stacked rice straw and also three pounds of concentrates daily from February 12 to April 23. In 1936-37 the test was repeated with 58 cows, from 10 to 13 per lot, with no concentrates fed to Lot V on Italian rye grass.

All groups lost weight during the wintering period with the exception of the dry cows in Lot IV (minerals and concentrates) which maintained the same weight. The cows that received concentrates lost less weight than the lots receiving no concentrates.

Out of a possible 128 calves in two years, 66 calves were dropped and 54 raised, or approximately 51% dropped and 41% raised respectively. In the two lots receiving feed both years, Lots III and IV, all calves dropped were raised, compared to a 36% death loss of calves in Lots I and II receiving no concentrates. Lot IV, receiving both concentrates and minerals, raised a 62% calf crop.

The calves from the two lots receiving concentrates were heavier when weighed in June than those from the lots fed no concentrates. Fourteen cows died during the two years, a death loss of 10.6%. The death loss in Lots I, II, and V was 15.2% compared to 7.2% for Lots III and IV fed concentrates. In Lot IV, receiving minerals and concentrates, only two cows died in the two years and they died during parturition. The results in regard to mineral feeding were inconclusive.

According to extension workers with beef cattle, possibly 75% of the beef cattlemen in the state are now practicing some form of winter feeding, as compared to an estimated 15% who did any feeding 20 years ago in the days of the cattle tick. Under such conditions cattle losses might run as high as 20% in some herds in a bad winter. In the same areas today cattlemen are culling their herds more carefully in the fall, and marketing their broken-mouthed cows and weak cattle, and reducing death losses to a marked degree.

If only a limited amount of feed is available, the cattleman will often separate and feed only such cattle as appear to be most in need of feed. This practice has good logic to recommend it, as some cows are able to put on good gains under conditions where others lose weight. Cows with young calves or those due to calve early need more feed than dry cows that are to calve in summer. Old, broken-mouthed cows usually need extra feed, though it is better practice to cull and market such cows in early summer. Weaned calves should always be fed. If calves go through the winter without extra feed, they are usually set back so that it will take several months of summer grazing to regain their fall weight, and they will not make full growth until four or five years of age. If yearlings are fed good roughage in winter with a pound or two of cottonseed meal or its equivalent they will start off in better shape the following spring and will be much larger as two-year-olds.

Feeds To Use In Wintering Cows

The cattleman will naturally use first whatever cheap feed is available, first of all such feed as the cattle can gather for themselves, and secondly, cheap roughage produced on the farm. Where the natural supply of forage is insufficient the first need of the beef cow is for fuel to maintain body heat, and cheap roughage will supply heat units at the lowest cost. Feeds like straw, corn fodder, and cottonseed hulls have a relatively higher value for wintering stock cattle than for feeding fattening steers or dairy cows. The beef cattleman is justified in using these cheap roughages as much as possible. Grass hay or pasture clippings stacked in the field is often used for wintering. Hay that has been rained on, so much as to be unsaleable or hay too weedy to sell will be eaten readily by cattle if thrown into rough stacks and held for winter use. Silage is used on a few farms but is not as important here as in the north, because of grass being available during all but a few weeks of winter. Cottonseed hulls are convenient to feed with cottonseed meal and are used a great deal in the cotton section.

The second need is for a limited supply of protein supplement, which in this state usually means cottonseed cake or meal, or sometimes cottonseed. A pound to a pound and half cottonseed meal per day for wintering a cow or a yearling will supply both protein and phosphorous, and will help materially in bringing the cattle through the winter in good condition. A pound of cottonseed meal per day supplies as much phosphorous as the animal would normally eat in a mineral supplement, and in addition supplies about the same heat and energy as a pound of corn.

References

Potter and Withycombe (27) of Oregon, state that oat and barley straw supplemented with cottonseed cake makes a good substitute for alfalfa hay, where it is intended merely to maintain the animals through the winter without any gain in weight. Withycombe reports that straw can be substituted for hay at the rate of 1½ pounds of straw for 1 pound of hay. The advantages found in feeding straw were due entirely to the low cost of straw.

Henley (19) Florida, found that feeding cottonseed cake on pasture or on a range was a much cheaper method of wintering the breeding herds than feeding cottonseed meal and silage in dry lot.

Vinke and Arnett (33) of the Montana station, reported that cows wintering on cheap roughage such as corn fodder, corn silage and straw made an average winter gain of 54.4 pounds and produced calves weighing more at weaning time than from cows fed alfalfa hay and cottonseed cake.

Lantow (22) New Mexico, fed cows on the range 1 pound per day and calves 1½ pounds per day of either cottonseed cake or ground yellow corn. The cows receiving cottonseed cake gained 56.9 pounds in 84 days as compared to 8.9 pounds gain from ground corn.

How Much Feed Is Necesary

One can not say definitely how much supplementary feed cows will need in Louisiana nor how much weight a cow should put on or might lose in winter. To decide this one must know the condition of the cow, when she is due to calve, and how much feed the cow can get for herself. A thin cow should put on at least 100 pounds in weight during fall and early winter in order to get through to spring grass and produce a good calf. On the other hand, a cow carrying 200 pounds of fat can lose most of this without harm. Nature intended the cow to use this fat for this particular purpose. The most serious death losses occur after cattle have used up all their surplus fat and begin to burn up other body tissues to maintain body heat. Some cows will keep in good shape under conditions where weaker ones will starve. The efficient cattleman will either adjust his numbers of cattle to his available feed supply, or will supplement his feed supply so that his cattle will come through until spring grass in fair breeding condition. Cows due to calve before grass comes will need better feed than those calving in late summer.

Cows in this test averaged 1000 to 1200 pounds of rice straw per head each winter during a period of 112 days. The cows receiving concentrates ate the same amount of straw as those fed no concentrates. All these cows had more pasture than many cows have in the rice area. The cows receiving concentrates, had 3 pounds feed per day for not over 112 days, some years less. The average cost of the concentrates for 3 years was about $3.67 per head. Two pounds per day might have been as satisfactory as three pounds. Cows eating hay from the stack will eat from ½ to ¾ ton per head. A ton and a half of silage or ¾ ton of cottonseed hulls will approximately replace ½ ton of hay.

Many of the cows wintered on rice straw without other feed except pasture produced three or four calves in four years and made satisfactory gains, but they had better than average pasture. The death losses were greater on rice straw alone and the calf crop not as large as where concentrates were fed.

References on Feeding Methods

Black (4) reporting on 2 years work in grazing beef cows found that cows maintaining their weight or even losing weight during winter made the largest summer gains on pasture. Black states that the main consideration in wintering cows is to use the most economical ration that will maintain weight.

Hart and Guilbert (18) California, suggest that if the cows are to be at a normal weight by calving time in the spring that they must put on gains during the late fall and early winter.

Lantow (23) New Mexico, found when feeding 1, 2, 3, and 4 pounds of cottonseed cake per day in wintering cattle the smaller amount of cake showed the greatest profit. Heavier feeding of cottonseed cake resulted in slower gains during the summer.

How Much Supplementary Feeding Is Profitable

The cattleman is in business to make money. If he can make more money by feeding he will supply extra feed, otherwise not. If $3.00 worth of extra feed will bring in $6.00 in increased gains, or a corresponding saving on death losses, it is good business to feed. If the cattleman spends $10.00 per head and gets only $9.00 increased returns it is not good business. However, the benefits from increased feeding will not be realized all in one year. Feeding cows in January and February of one year can not greatly affect the number of calves dropped in the spring, but may affect the number of calves saved, may save some cows, and may increase the number of calves produced the following year. Most cattlemen realize the value of feeding and do whatever they believe will make them the greatest profit.

In this test the difference in percentage calf crop due to feeding was about 6 per cent. That is, out of 100 cows there would have been 6 more calves dropped which if worth $35.00 per head would mean a difference of $210.00. The difference in weight of calves at weaning in 1942 was 36 pounds in favor of supplementary feeding, an additional return of about $4.75 per calf, or $356.00 per 100 breeding cows. A 5% lower death loss, with cows valued at $35.00 each, would mean $175.00 saved per year on 100 cows, or $200.00 saved on $40.00 cows, making a total of $741.00 to $766.00 increased returns for an expenditure of $367.00 to $500.00 worth of feed.

These are only estimated profits and death losses. Even in good herds a death loss of 2 or 3 per cent might be considered normal depending on how many old cows are kept. Many herds in the state show much higher death loss than these recorded in this experiment. Where an animal's resistance is lowered from starvation or any other cause it is more likely to succumb to disease and more likely to die from cold or from getting bogged down. The cattleman must maintain a reasonable balance between cost and income if he is to succeed. Whatever suggestions are made here can only be considered as general guides, and not as absolute requirements.

References on Profits From Feeding

Adams (1) California, found that the costs of producing calves to the end of the calendar year in which they were born, varied from $22.47 to $58.70, and feed costs ranged from 41% to 60% of the total annual costs. Adams states that economy of feed costs is best brought about by improving the range or pasture and by the use of home grown roughage.

Black and others (5) Texas, state that ranchmen have the object in view, to winter their breeding cows with a minimum outlay of feed and labor and still obtain a normal number of good calves. Calves from cows fed cottonseed cake were on the average heavier at birth and at weaning time than those fed no supplements.

Burdick and others (7) Colorado, state that ranches using less than $2.00 worth of winter feed per cow consumed an average of $1.37 worth of winter feed and produced a calf crop of 53%. The group using over $2.00 worth of winter feed per cow had an average cost of $3.16 per head and a calf crop of 62% (1922-1924 feed prices).

Campbell and Rhodes (8) investigating beef production methods on Louisiana forest lands found that with herds reasonably well cared for, losses ranged from 1.6% to 3%, and calf crops ranged from 69% to 78%. Herds that were inadequately fed had death losses of 6% to 8% and produced calf crops of 30% and 40%. Adequate feeding usually meant 1 to 2 pounds cottonseed meal with at least 4 pounds hulls or 8 pounds of hay per day. The calves from the better fed cows were at least 5 pounds heavier at weaning time.

Cobb and Gayden (10) Louisiana, list the benefits to be derived from winter care as follows: Prevents death losses, increases percentage of calves, increases birth weight of calves, increases useful life of the cow, reduces the number of bulls necessary for the herd, allows young stock a chance to develop as they should and brings them into the herd earlier, increases gains on pasture by allowing a quicker recovery from winter conditions, and by maintaining thrift and vigor, the general health and resistance to diseases and parasites is maintained.

Stanley (32) Arizona, reported that cows receiving cottonseed cake, bone meal and salt produced calves averaging 5 pounds more at birth, but stated that feeding did not pay where the natural forage was sufficient for maintenance.

Vinke, Dickson, and Arnett (34-35) Montana, found that cows might have heavy losses in weight during the winter and still produce normal calves at birth. Cows might be wintered on almost any kind of ration, but deficient rations could not be extended too long a time or into the calving season. Cows that made an average winter gain of 100 pounds produced smaller calves than those that made an average winter gain of 32 pounds. Cows wintered on cheap roughage such as corn fodder, corn silage, and straw produced heavier calves at weaning time than cows fed alfalfa hay and cottonseed cake.

Wagnon and others (36) California, reported that the increased income per cow based on a price of 8 cents per pound for calves at weaning time was $3.00 to $6.36 per cow above the cost of feed. Where herds were fed cake on the San Joaquin Valley Range, California the total pounds of calf production per breeding cow was over 100 pounds greater than where no supplementary feed was fed.

Woodward, Clark, and Cummings (8) Montana, found that calves were slightly heavier at birth from 3 year old cows that were heavily fed during the winter than calves from 3 year old cows on limited feeding, but with the older cows there was not any recognizable difference. The size of the cow had more influence on the birth weight of calves than the type of feeding.

When Is It Necessary To Supply Minerals

The chief mineral deficiences in some parts of Louisiana are in calcium and phosphorous. We do not know definitely that there is any deficiency in other elements, such as iron and copper. On the better lands of the state there appears to be no advantage in feeding minerals.

Ground oystershell or ground limestone supply calcium, so also will legume hay. Phosphorous may be supplied by feeding cottonseed meal or cottonseed cake in winter or by mixtures containing bone meal, Di-sodium phosphate or Di-calcium phosphate. Rock phosphate used in commercial fertilizer should never be used in mineral mixtures. The most effective way to supply minerals to live stock is to apply lime and phosphorous to the land and let the cattle get their minerals in the grass and other forages.

Where there is a known deficiency in mineral matter, as there is in parts of Texas, Montana, California and elsewhere (References 5-11-12-13-14-16-25-26-28-29-33-37) the feeding of the right minerals may make a great deal of difference in the growth and breeding capacity of cattle. If there is reason to believe that a deficiency exists, a simple mineral mixture of 20 parts salt, 40 parts steamed bone meal, and 40 parts ground oystershell should be put out under shelter where cattle can get it freely. They will not eat more than is good for them. Salt should be supplied separately in addition.

It should not be thought that because outstanding results have been obtained from feeding minerals in places where the soil is deficient the same good effects will result anywhere if minerals are fed. Minerals will not take the place of feed.

References on Mineral Feeding

Hart and Guilbert (18) California, state that where the forage on a range consists largely of bur clover, foxtail, wild oats, needle brome and salt grass, a herd of 225 head of cows produced only 68 calves after one year on this range while on this same pasture two other herds fed bone meal weaned 71.5% and 85% calf crops one year and an 86% and an 88% calf crop the following year.

Knox and others (21), New Mexico, report that on deficient range cows ate 9 to 14 pounds of di-calcium phosphate a year, equivalent to 12½ to 18 pounds of bone meal. Breeding cows receiving a phosphorus supplement produced more living calves and heavier calves than the cows which had no supplement. The average return for each dollar spent on mineral supplements was $16.17.

Lantow (22), New Mexico, states that minerals will not replace the benefits derived from the protein of cottonseed cake in winter. Heifers having their first calves did so with greater ease and less death loss and had stronger calves when they had access to calcium and phosphorus supplements.

Palmer and Gullickson (26) state the use of calcium and phosphorus supplements will not prevent or cure abortion or reduce sterility in cattle, but that bone meal or other phosphorus-bearing mineral supplements will usually make breeding more regular.

Reed and Huffman (28), Michigan, found that "Complex mineral mixtures injured the health of the cows to which they were fed." There was no evident advantage and some danger in feeding minerals unnecessarily.

Schmidt (29), Texas, found that cows getting bone meal on a phosphorus deficient range raised calves weighing 21 pounds more at 200 days of age than those receiving no supplements. In one test, 5 out of 44 test cows (mineral feed) and 13 out of 50 control cows died during the second year of the test. Fifteen of the cows receiving no minerals developed "creeps" during the summer of 1925.

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APPENDIX

CALCIUM AND PHOSPHORUS IN BLOOD SERUM

A good index of phosphorus deficiency is the phosphorus content of the blood serum. Analyses of blood samples for calcium and phosphorus in this test were made by A. P. Kerr, State Chemist, in 1939-40. Table XIV gives the results of the analyses in milligrams of phosphorus and calcium per 100 cc of blood serum. Five milligrams (5.0 mgs) of phosphorus and upwards is considered good, 4 mgs and above is low to medium, and 3 mgs or less indicate a seriously low phosphorus intake. The calcium content of the blood is regulated by the parathyroid glands and does not vary as much as does phosphorus. Calcium in the blood serum usually varies from 9.5 mgs per 100 cc serum up to 11 to 12 milligrams.

ANALYSES OF BLOOD SAMPLES FOR CALCIUM AND PHOSPHORUS

Table XIV Feb. 9, 1939 — Feb. 26, 1940

PHOSPHORUS. Milligrams Per 100 cc Blood Serum

Date	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
2-9-29	4.83	4.96	4.30	5.81	4.72	5.55	6.01	4.91
3-23-39	4.16	3.59	4.62	3.69	3.98	3.74	4.02	4.19
6-1-39	5.83	5.37	2.68	4.14	5.17	4.83	5.44	4.14
6-29-39	5.14	2.14	2.54	2.54	3.72	2.98	4.44	3.16
10-4-39	3.99	3.45	3.64	1.93*	3.43	2.28	2.34	3.19
10-14-39	4.01	2.95	3.93	6.08	3.50	4.25	3.25	4.59
2-26-40	3.89	3.62	4.54	4.48	4.15	6.06	7.14	4.86
Average	4.54	3.72	3.75	4.09	4.09	4.24	4.66	4.16

* Possibly an error.

CALCIUM. Milligrams Per 100 cc Blood Serum

Date	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
2-9-39	9.86	9.93	9.86	9.84	9.18	10.23	9.74	8.81
3-23-39	10.97	10.77	10.30	10.85	11.10	10.95	10.95	10.20
6-1-39	9.29	9.58	8.19	9.33	9.44	9.50	9.61	9.52
6-29-39	9.71	9.42	9.57	9.64	9.66	9.42	9.77	9.80
10-4-39	10.18	10.52	9.89	10.14	10.23	10.38	10.25	10.09
10-14-39	9.82	11.40	10.32	9.10	9.55	10.45	10.14	9.55
2-26-40	9.53	9.94	10.25	10.32	10.18	9.58	9.16	9.82
Average	9.91	10.22	9.78	9.87	9.90	10.07	9.94	9.68

The analyses for phosphorus shows that the blood samples rarely were above the 5.00 mgs level, even in the mineral and concentrate fed lots, and were usually below the 4.00 mgs. level during the latter part of the summer. The phosphorus content of the blood usually declined after June 1st, and continued to decrease until the middle of October when there was usually a slight increase. Lot 7, receiving both concentrates and di-sodium phosphate, showed a higher concentration of blood phosphorus during the winter feeding periods in February 1939 and in 1940, but was lower around October 4th than in most of the other lots. The three lots receiving both concentrates and mineral supplements showed a higher phosphorus index than those receiving minerals mixtures alone, however, Lot 5, receiving concentrates but no minerals, seemed to run consistently lower than Lot 1, receiving neither concentrates or minerals. This may be without significance.

The blood calcium index was quite uniform in all lots with no variations of special significance. In Lots 2 and 6, which received ground oystershell, the average was slightly above 10 milligrams per 100 cc, but the margin over the check lots was very slight.

As a check-up on these analyses, in September 1944, blood samples were taken from two groups of grade Angus heifers grazed on these same fields. Half of these heifers were on unfertilized land where Lots 3 and 4 grazed during this test, while the remainder were on similar land which was limed and fertilized, in 1944. The phosphorus in both lots was above 5 milligrams per 100 cc serum. The heifers on unfertilized pasture showed a slightly higher index than the others, being 5.24 compared to 5.09 mg. for the heifers on the fertilized pasture, indicating that there was no marked phosphorus deficiency in the native unfertilized pasture. In the test for calcium the heifers on limed and fertilized pasture showed a noticeably higher calcium index, being 12.76 mg. compared to 10.03 mg. from the unfertilized pasture.

These analyses indicate that the native pastures are not seriously low in phosphorus at least for mature cattle. Although the average blood phosphorus in Lots 2 and 3 was below 4 mg. per 100 cc, this is not as low as in some tests reported by Knox, Benner and Watkins (21) of New Mexico, even for cows receiving di-calcium phosphate. These investigators doubt whether 4.0 mg. phosphorus is the minimum level consistent with good health in range cows.

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The Vitamin A Content of Louisiana Milk and Butter as Related to Nature of Pasture

By

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The Vitamin A Content of Louisiana Milk and Butter as Related to Nature of Pasture

By

E. A. Fieger and Harvye Lewis

INTRODUCTION

Milk and dairy products are important foods because of the quantities in which they are consumed and the food essentials which they supply. The proteins, carbohydrates, and minerals such as calcium and phophorus are present in rather constant amounts and do not vary greatly with breed or type of feed consumed, while the fat content varies with breed. In general, though, it can be considered that the above mentioned nutrients do not vary greatly with the nature of the feed. The total vitamin A content of milk, however, is affected by the diet of the animal and to a less extent by the breed. Because of the importance of the nature of the diet with regard to the vitamin A content of milk, a study was undertaken to determine the vitamin A content of Louisiana produced milk and butter.

From the standpoint of health it is necessary to know something of the vitamin A content of the milk and butter consumed, since these two foods are important vitamin A sources. Another value of such a study lies in showing the effect of young green pastures upon the vitamin A content of milk from cows upon such pastures and lastly to indicate how better milk, from the standpoint of this vitamin, can be produced.

It is the purpose of this investigation to report the carotene and vitamin A values of milk received each month from 25 dairy herds and from six creameries and of butter received monthly from two butter manufacturers for the months of October, 1943, to April, 1944, inclusive.

VITAMIN A IN NUTRITION

Vitamin A activity may be present in a food either as vitamin A itself, or as carotene, a yellow pigment, which is converted into vitamin A by the body. Carotene is present in high amounts in green leaves, grasses, and green and yellow vegetables. Human and animal foods which furnish high amounts of carotene are carrots, sweet potatoes, all varieties of greens, lettuce, clover, alfalfa, and oat and rye grasses. A small amount of carotene is found in a yellow corn, but other grains do not contain any of this provitamin. Milk contains both vitamin A and carotene, the latter being obtained directly from the diet of the animal.

Human beings, as well as animals, require vitamin A or carotene, or a combination of vitamin A and carotene in their diets in order to have normal growth, development, and health. They also have a remarkable capacity for storing vitamin A in their livers, and this storage is utilized when the food intake does not provide sufficient amounts of this material. When the body stores have become practically exhausted, signs of vitamin A deficiency soon become apparent. The earliest recognizable symptom of such deficiency is night blindness, a visual defect that makes the eyes less responsive to dim light. After being exposed to a bright light, the eyes of a night-blind person cannot adjust in the darkness to the same low degree of illumination as can the eyes of a well nourished person.

A more severe or a more prolonged vitamin A deficiency results in extreme muscular weakness and changes, a hardening of the lining of the mouth, lungs, digestive system, in fact the linings of all the cavities within the body. These changes may lead to invasion by disease germs thereby causing infections so that sometimes vitamin A has been called the anti-infective vitamin. Defective tooth structure and deformities of the teeth may occur during periods of tooth formation when there is a deficiency of vitamin A.

The human requirements for vitamin A are not definitely known. The Food and Nutrition Board of the National Research Council has suggested the following amounts daily as meeting the requirements of human beings:

Children under 1 year	1,500 I. U.
Children 1-3 years	2,000 I. U.
Children 4-6 years	2,500 I. U.
Children 7-9 years	3,500 I. U.
Children 10-12 years	4,500 I. U.
Adults	5,000 I. U.

(The International Unit (I. U.) of vitamin A is 0.0006 milligrams of pure beta carotene. For vitamin A itself, 0.0003 milligrams is equivalent to one International Unit.)

The cow normally obtains vitamin A in the form of carotene, which is found in plant material. It is well known that the vitamin A content of milk is definitely influenced by the carotene of the forage fed, the more verdant feeds being higher in carotene. Since it is necesary that the cow's diet be high in carotene in order to maintain good nutrition and secrete milk rich in vitamin A, one can understand the importance of green pasture.

Feeds low in carotene, which should be supplemented with carotene-rich feeds if fed to cattle over an extended period, are cottonseed meal and hulls; linseed and soybean meals; wheat, oat barley, corn (white or yellow) and sorghum grains; beet pulp and molasses; cereal straw; corn stover; low grade legume or grass hays; range herbage during extended periods of drought; and hays held in storage more than one year. Feeds rich in carotene are green pasture (grass, legume, or browse); high grade green, leafy hay (legume, grass, or cereal) of the current years crop; well made silage; and new high grade alfalfa meal.

With dairy cows, vitamin A deficiency is likely to occur where the quality of the hay crop is poor as a result of unfortunate conditions during curing, where legume hay is not available, or where insufficient roughage is fed. In the case of cattle on range or pasture, very serious vitamin A deficiency may be caused by long continued drought.

Mature cows suffering from vitamin A deficiency show the condition first by premature calving or by throwing weak or dead calves. This abnormality in reproduction is likely to appear in 5 months if the roughage of the ration consists entirely of either U. S. No. 3 alfalfa hay or U. S. No. 3 Timothy hay. Calves less than six months old are likely to show the effects of lack of vitamin A by marked retardation of growth, and finally by death from calf pneumonia. Blindness and infections of the eyes also are frequent symptoms.

The minimum requirements of vitamin A and varotene needed to cure night blindness in various species of animals have been determined by Hart (3) as follows:

	Daily intake per kilogram (2.2 pounds) of body weight	
	Vitamin A in I. U.	Carotene in I. U.
Cattle	21-27	43-55
Sheep	17-26	47-58
Swine	18-24	42-65
Horses	17-22	33-50

Hart recommends that at least five to ten times the minimum level of carotene and vitamin A should be furnished under practical conditions since little or no storage occurs at the minimum level needed to prevent night blindness.

The yield of milk is affected only slightly, if at all, by a deficiency of vitamin A or of carotene in the diet of the cow. Normal milk secretion may ensue even after a deficiency of vitamin A sufficient to interfere with normal calving.

Conversely, one of the most variable properties of milk is its vitamin A potency*. Generally, between 75 per cent and 90 per cent of the natural color in butterfat is due to carotene derived directly from the feed, and the remaining color to xanthophylls, vegetable pigments which the body is unable to convert into vitamin A. As a result of differences in the carotene content of the diet, some butterfats may be 15 times as highly colored as others, even though from the same breed, and such differences in color are a rough indication of the vitamin A potency of the milk. With very large quantities of carotene in the diet, however, vitamin A in the butterfat appears to reach a rather definite ceiling value.

Some species of animals convert carotene into vitamin A more completely than others. This alters the proportions of the vitamin A potency in the milk fat that are due to carotene or to the colorless vitamin A derived from it. This fact is also true for different breeds of cattle. Using the same diets, Jerseys and Guernseys secrete a more highly colored butterfat than Holstein-Fresians, Brown Swiss, or Ayrshires; but this does not necessarily mean that butterfat from the Jersey and Guernsey milk is correspondingly richer in vitamin A.

DESCRIPTION OF SAMPLES

Each month an adequate sample of milk was received from each of the 25 dairy herd cooperators together with a statement of type of pasture and its condition, nature of roughage and concentrate which were fed, and the number of cows which freshened. The following were determined: specific gravity and the fat, carotene and vitamin A content. The state was divided into three geographical sections, Samples 1 to 7 inclusive being from the Northern Section, Samples 20, 21, and 22 from the Central section and Samples 8 to 19 and 32 to 34 inclusive are from the Southern section.

Monthly samples were obtained from creameries located in the six largest cities of the state and the same determinations were made as upon the herd milk.

The butter samples were obtained monthly from two butter manufacturers, one located in the northern section of the state and the other in the southern section. These samples were analyzed for fat, carotene, and vitamin A content.

VITAMIN A POTENCY OF HERD MILK

Since human beings can use either vitamin A or its precursor, carotene, by converting the latter into vitamin A in the liver, the data reported here includes the sum of vitamin A and carotene, expressed on the basis of International Units per quart and per gram of butterfat. The use of the former expression, International Units per quart, is of particular interest to the ultimate consumers since they buy and use milk on the basis of volume, (cups, pints, and quarts) and can readily determine from these values the amount of vitamin A supplied by the fluid milk consumed. The latter method of expressing vitamin A potency, International Units per gram of butterfat, is used since it eliminates inequalities due to differences in butterfat content of various samples of milk. Both carotene and vitamin A are present only in the butterfat portion of the milk and it is readily apparent that the potency of milk will depend not only on the amount of these substances present in a given weight of butterfat but also the percentage of the butterfat in the milk. Milk from Jersey or Guernsey cows in general have a higher potency per quart than milk from Holstein cows since the former have an appreciably higher fat content while the potency per gram of butterfat for these three breeds is quite similar.

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* Vitamin A potency refers to the total amount of vitamin A and carotene present.

The data reported in Table I represents values expressed in International Units per quart, obtained from herd milk as received from 25 milk producers, while in Table IA the values are expressed in International Units per gram of butterfat for the same set of samples.

The milk produced in the northern section of the state during the period under consideration is somewhat lower in vitamin A potency than that produced in the more southern parts of the state. This fact is brought out more clearly in Table IA where the results are expressed in International Units per gram of butterfat. Two reasons can be advanced to explain this lower potency: the effects of a severe drought upon pastures during the summer and fall of 1943, and the lower average temperature in that section during the winter, which caused decreased growth of both native pastures and supplemental pastures. The later development of green spring vegetation in this section of the state is reflected in the lower average values for March and April milks. On a qualitative basis, milk of fair vitamin A potency was produced during the three winter months of December, January, and February; of good potency during November and March; and of excellent quality during October and April. The low values reported for herds 3, 4, and 6 during the winter was caused by a lack of sufficient pasture and its overgrazed and brown condition.

The results for milks from the central section of the state reflect the effects of good dairy management, good growing conditions and excellent soil. These herds had ample good roughage, consisting of locally grown hay and silage, and in addition two, Nos. 21 and 22, had access to supplemental oat pasture. The increase in potency for December milk in comparison with November milk was brought about by favorable fall weather resulting in good oat pasture. The lower values for January and February were the result of cold wet weather which extended from December to the latter part of January and severely limited vegetative growth and grazing. Milk of good potency was produced during the winter period, and of excellent potency in October, March, and April.

The milk produced in the southern section of the state during the period under consideration was of fair vitamin A potency in November and January; of good potency in October, December, and February; and of excellent potency in March and April. The increase shown for the December samples resulted mainly from the use of supplemental oat pasture by some of the producers and the favorable fall weather for the growth of winter grasses. The December samples were all received by the 15th of the month which was before the killing frost which occurred on that date. The decrease noted for January and the slight rise in February was the result of the wet cold period which extended from the middle of December to the end of January. The warm favorable weather of February while resulting in excellent pastures in the latter part of that month was not reflected to an appreciable extent in the results since a majority of the samples were collected in the early part of the month. It should be noted that a period of time elapes between the time cows are placed on a green pasture, after a period on dead winter pastures or no pastures, before an increase appears in the vitamin A and carotene content of the milk. This fact will be further emphasized under the discussion of effects of supplemental oat pastures. The high vitamin A potencies reported for March and April were the result of excellent improved and native pastures, and the good growth and wide use of clover as well as supplemental oat and Italian rye grass pastures.

Since milk of excellent quality was produced during October, March,and April by practically all cooperators, little improvement can be expected for those months by any change in present feeding and pasture practices. In fact, the values obtained for April represent about the maximum or ceiling value of vitamin A in cows milk. A consideration of the four winter months, November through February, indicate low values both on the basis of units per quart and per gram of butterfat, and suggest that it may be worth while to consider the adequacy of the average dairyman's feed and pasture program during the winter months.

A consideration of the nutritive quality of milk in supplying carotene and vitamin A in the diet should be of interest to all Louisiana citizens. In general, it is to be noted a quart of herd milk daily will supply enough of this nutritive essential to meet the daily needs of children under one year of age during the three winter months when milk of lowest vitamin A potency is produced. Early fall and spring milk will supply a sufficiency of this vitamin per quart to meet the daily need of children up to six years of age. This is important since milk is the foundation of the diet of infants and growing children. For adults, whole milk is a valuable food material and makes a definite contribution to their need for this vitamin.

VITAMIN A POTENCY OF CREAMERY MILK

The vitamin A value of creamery milk is reported in Table II, and, as is to be expected, parallels quite closely the data reported for herd milk. From a good vitamin A potency in October the samples reached a low value in November, December, and January, while the February samples averaged slightly higher. The assays for March and April indicate milk of excellent quality.

Since the urban population largely consumes milk purchased from creameries, a knowledge of the vitamin A potency of such milk is important in a consideration of the adequacy of their diets with respects to this vitamin. On the basis of recommended amounts of vitamin A considered necessary daily for adults, one quart of this winter milk per person will supply one-fifth of the daily need, while spring milk will supply from two-fifth to one-half the daily need.

VITAMIN A POTENCY OF BUTTER

Butter is one of the best sources of vitamin A of all the foods used in the human diet. Although only two samples were analysed monthly, the creameries producing this butter account for more than two-fifths the total creamery butter production of the state. It can be considered, therefore, that although the number of samples is limited, they are representative of average Louisiana butter. The values for butter produced in October, March, and April (Table II) represent butters of excellent vitamin A potency. During the remaining months reported, the Vitamin A values were somewhat higher than butters produced in other regions of the country during the same period of the year. Since the average prewar consumption of butter per person was 18 pounds per year, or 0.8 oz. daily, winter butter supplies daily, on this basis, 500 International Units of vitamin A, while butter produced in the spring will supply about twice that amount daily or one-fifth the daily need. From the point of view of nutrition, adequate amounts of butter should be present in the diet.

VALUE OF SUPPLEMENTAL OAT OR ITALIAN RYE GRASS PASTURES

The value of green winter pasture as represented by rye, oats, or barley in increasing milk production has been stressed by the Louisiana Agricultural Experiment Station since 1929. Beginning with the Biennial report of that year and continuing to the present, the North Louisiana Experiment Station has reported the effect of winter pastures, particularly oat pasture. In the 1929-1931 report the respective acre values of rye, oats, and barley as pasture on a basis of 40 cents per pound butterfat for 1931 are given as $9.77, $11.35, and $4.10. The oats also gave 2.61 tons hay per acre. Also Lush reported rye grass and clover in January contained more than 26 per cent protein. In the 1935-1936 report Lush further showed that winter grazing on oat pasture averaged 2.2 pounds more milk per cow daily than permanent pasture or no pasture. The oats also averaged 1.5 tons of excellent hay per acre when grazing was discontinued about March 15th. Practically the same increase in milk production, 2.26 pounds daily, was reported in the next biennium and finally in the 1941-1942 report an increase of 4.8 pounds per cow daily or 22.5 per cent in production of milk was shown during one week's time when cows were turned onto oat pasture in February. These results obtained by the North Louisiana Experiment Station stress the value of supplemental oat pasture in increasing milk production as well as a source of hay. Another factor to consider in the use of oat pasture in the winter months is its effect upon the vitamin A potency of milk from cows grazed on such pasture.

Out of a total 25 herds cooperating, 14 were grazed on oat or rye grass pasture during some period of the winter and spring. A study of the results obtained (Table III) show, for average values, no increase for November, a marked increase, 780 International Units per quart, for December and a constant increase of approximately 440 International Units per quart for the remaining months, when milk from herds on oat or rye grass pasture was compared with that from herds without access to such pastures. No explanation for the almost constant increase for the last four months is known, but it is rather remarkable that this increase was maintained during March and April when practically all herds were on excellent natural or improved pastures most of which contained good growth of clovers. In the case of only two herds, Nos. 10 and 11, is it possible to directly compare the effect on vitamin A potency of oat pasture with natural pasture. In the case of these herds two different groups of cows were placed on such pastures while the remainder of the herds were grazed on their natural pasture. The increase in potency for the Jersey cows (group 10A) for December was 268 International Units and for January 117 International Units per quart, while the Holstein cows (group 11A) had increases of 118 International Units and 67 International Units respectively. It should be pointed out that while the increase for December for these herds was not as great as the increase shown in the average values given, samples from herds 10 and 11 were showing the effect of 12 days grazing on oat pasture during the middle of November. This is the result of the animal's ability not only to store vitamin A in the liver and other tissues during periods when an ample amount of carotene is present in the feed, but also to release this stored material gradually during periods when the feed is low in carotene.

The slightly higher values for 10B and 11B for February when compared to 10 and 11 respectively give a qualitative idea of the amount of carotene supplied by oat pasture when compared to natural pasture containing some growth of clover. Samples 10B and 11B were from cows on oat pasture two hours per day and then placed in feed lot, while the remainder of the herds were pastured for the entire day on native pasture. The roughage and concentrate fed were the same for both herds. It appears therefore that two hours of grazing on dark green oat pasture is slightly better for supplying vitamin A and carotene in the milk than eight to ten hours of good light green colored natural pasture.

The effect of the cold wet weather during the last half of December and most of January is reflected in the drop in average values for January from the December results and the small rise in February when compared with January. This was caused by limited growth of vegetation and a soil condition too wet to allow grazing.

With respect to milk yields, cooperators 10 and 11 reported for December an average increase of approximately 20 per cent due to oat pasture which confirms results obtained at the North Louisiana Station. Increased milk yields, increased vitamin A potency of milk, a source of hay, better health of the herd and a smaller quantity of roughage needed are some of the advantages which dairy farmers can obtain by the use of supplemental oat pasture during the winter.

EFFECT OF CLOVER

The clovers have been considered a valuable crop as a soil builder and as an excellent source of hay and forage because of high protein content. To the farmers of Louisiana they are also of further value because of sufficient growth in the late winter and early spring to afford good pasture when spring grasses are still dormant. As is to be expected, this also affects the vitamin A potency of milk produced during this period as shown in Table IV. For February and March both International Units per quart and per gram of butterfat show appreciable increases over herds on native pastures only; while for April, the quantity of vitamin A per quart is somewhat less, but the amount per gram of butterfat is higher.

A comparison of oat, clover, and native pastures for the period

November to April (Fig. 1) graphically show the effect of these upon the vitamin A potency of herd milk. The use of oat pasture during the winter months followed by improved pasture containing clover will result in the production of high vitamin A quality milk when ordinary pasture results in the production of milk of lowest quality.

COMPARISON OF VITAMIN A CONTENT OF MILK PRODUCED IN VARIOUS REGIONS

During the past few years considerable interest has been shown by several experiment stations in the vitamin A content of milk and the manner in which pasture and feeding practices affect its content of this vitamin. The results obtained in the four states where such analyses have been made (Table V) all show minimum or lowest vitamin A content during the winter months. The lowest values obtained varied during this period at the various locations. For Louisiana it occurred during January for herd milk and November, December, and January for creamery milk; for Alabama (4) during January and February; and for Arizona (2) during January for herds on pasture, and for cows given hay and silage during November, December, and January. At Wisconsin (1) the low point is reached much later in the winter, falling in March and April.

Three of the stations studied additionally the effect of pasture or feeding practices. Two of these, Alabama and Louisiana, studied the effect of supplemental pastures, while Arizona compared the effect of permanent pasture and hay or hay and silage as the sources of roughage. All these results show the value of high carotene containing feedstuffs in increasing the vitamin A content of milk. The data from Alabama was obtained using the Alabama Polytechnic College herd of pure-bred Jerseys. In this work only a few cows were pastured on supplemental rye pasture, so that these cows at all times during the experiment had available excellent green feed. The Louisiana results are the average of a varying number of herds and in many instances the supplemental pastures were over grazed. This probably explains the larger increases shown by the Alabama results. From the Arizona results it is evident that milk from cows receiving roughage in the form of pasture is definitely higher in total vitamin A potency than from cows receiving hay or hay and silage without any green feed. Similarly the sharp decrease in potency shown in the December results at Wisconsin occurred soon after the herds were removed from pasture in the fall, and continued to decrease until the cows were again on pasture in May.

These results illustrate the need for careful planning and development of pasture programs which will result in ample green roughage. For Louisiana the use of fall planted oat or rye grass is recommended to supply green pasture during the winter months when native and improved pastures are dormant and supplying roughage of poor quality. This program in conjunction with improved pasture containing clover to augment the supplemental pasture in the late winter and early spring will result in the production of milk of high vitamin A potency. This program will result in increased milk production as well as supplying ample roughage, and during winters having favorable weather and with pasture of ample size may result in obtaining a crop of oat hay later in the season.

SUMMARY

Milk from 25 dairy herds, received monthly from October to April, was analysed for vitamin A and carotene, and shown to have an average vitamin A potency which varied from 1280 International Units per quart in January to 2805 International Units per quart in April. The quality, from a vitamin A point of view, was fair for the four winter months of November, December, January, and February, and of excellent quality for the October, March, and April samples. Winter herd milk supplies, per quart, approximately one-fourth an adult's daily need for this vitamin, while fall and spring milk supplies two-fifths to three-fifths of the daily need per quart.

The average values for the six creamery samples obtained during the same period were slightly lower than that of the herd samples, varying from 993 International Units per quart to 2507 International Units in April. For the four winter months the milk was of fair vitamin A quality, one quart supplying one-fifth of an adult's daily need. October milk was of good quality, supplying one-fourth of an adult's daily need, while the spring milk was of excellent quality, a quart supplying two-fifths to one-half of an adult's daily need.

The quality of Louisiana produced butter, during the same period, was average for the four winter months of November to February and for the remaining months was of excellent quality. The values in International Units per pound varied from 7,918 to 23,157.

Fall planted oats for use as pasture during the winter and early spring resulted in raising the vitamin A quality of the milk from fair to excellent. The increase for December was 780 International Units per quart, and for the rest of the months reported, a practically constant average increase of 440 International Units. Besides increasing the quality of the milk, oat pastures result in (1) increased milk yields, (2) better health of the herds, (3) less roughage required, and (4) may yield a late spring crop of hay.

Clover pastures are recommended as a means of supplying late winter and early spring pastures as well as for increasing the vitamin A potency of milk.

By having available supplemental oat pastures and improved clover pastures Louisiana dairy farmers, besides being assured of ample forage, will be supplying milk of good to excellent quality during the period October through April, or during the winter period when cows on native pastures are producing milk of lowest vitamin A quality.

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TABLE 1

VITAMIN A POTENCY OF HERD MILK

International Units Per Quart

Coop. No.	Breed	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
Northern Section of State								
1	Jersey	2913	2185	1148	1170	1060	2089	2824
2	Jersey	1692	1570	1908	1428	1417	2291	3267
3	Jersey	1840	1302	974	968	1397	1526	2023
4	Holstein	1296	768	683	510	724	1072	1507
5	Jersey	1529	1612	1367	1441			
6	Jersey	1704	744	764	924	646	1353	2426
7	Jersey	3067	1819	1734	1017	1608	2102	3345
Average		2006	1428	1225	1065	1142	1739	2565
Central Section of State								
20	Holstein	1845	1267	1514	984	1083	1966	2152
21	Jersey	2517	1821	2399	1185	1428	2585	3232
22	Guernsey	2558	1581	1886	2130	1758	2633	3130
Average		2307	1556	1933	1433	1423	2395	2838
Southern Section of State								
8	Jersey	1596	1022	2235	1114	2337	3673	3192
9	Holstein	1106	397	1710	695	1861	2584	2817
10	Jersey	2561	1466	1876	1745	2807	3257	3683
11	Holstein	1444	879	1364	1157	1899	2493	3028
12	Jersey	1556	1403	1143	1116	1129	1359	2742
13	Holstein		1387	1180	1471	1275	1728	2775
14	Jersey		1999	1895	1754	1366	2214	3932
15	Holstein		1272	778	960	1217	1849	
16	Jersey		1904	898	936	1278	2706	2397
17	Jersey	2351	1187	2459	1287	1504	2840	3334
18	Mixed	2533	1023	1382	1256	1665	1766	2306
19	Jersey	1571	1270	1451	2044	1242	2140	2561
32	Jersey				2667	1667	1884	2431
33	Jersey				877	1060	2011	2404
34	Jersey				1164	1985	2757	3020
Average		1840	1267	1531	1349	1559	2351	2901
Grand Average		1987	1358	1519	1280	1433	2203	2805

VITAMIN A POTENCY OF HERD MILK

International Units Per Gram Butterfat

Coop. No.	Breed	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
Northern Section of State								
1	Jersey	56.22	43.02	25.83	24.96	40.07	45.41	65.46
2	Jersey	34.62	29.77	36.53	27.27	29.81	44.26	68.75
3	Jersey	43.83	24.84	18.45	17.96	24.18	30.55	43.90
4	Holstein	41.47	18.43	16.87	24.23	17.59	29.57	46.64
5	Jersey	34.38	28.41	25.99	27.07			
6	Jersey	39.17	15.40	18.19	20.13	17.62	30.43	45.88
7	Jersey	43.19	41.72	31.16	31.16	44.99	49.61	63.26
Average		41.84	28.79	24.92	24.68	29.04	38.30	55.65
Central Section of State								
20	Holstein	65.22	37.83	49.23	35.35	35.77	62.92	74.63
21	Jersey	49.18	51.11	62.97	39.11	44.23	67.73	88.07
22	Guernsey	52.75	28.66	41.48	39.75	30.91	47.07	91.22
Average		55.72	39.20	51.23	38.07	36.97	59.24	84.64
Southern Section of State								
8	Jersey	46.68	25.47	41.59	27.15	51.87	69.34	68.50
9	Holstein	56.18	14.05	47.41	26.38	58.61	33.28	104.81
10	Jersey	47.66	27.22	34.26	35.72	51.18	55.43	68.33
11	Holstein	41.74	31.57	37.74	25.41	48.97	61.41	86.00
12	Jersey	30.35	29.64	23.17	25.14	27.47	31.58	70.10
13	Holstein		32.71	34.10	30.77	40.16	50.55	79.96
14	Jersey		34.96	37.69	32.98	27.37	46.10	71.10
15	Holstein		32.64	23.47	26.17	27.91	56.41	
16	Jersey		30.51	15.72	17.07	21.76	50.22	47.07
17	Jersey	60.12	29.98	49.83	25.26	31.35	49.43	65.40
18	Mixed	26.30	21.37	28.92	27.65	42.87	35.87	56.72
19	Jersey	31.48	13.32	18.26	26.71	25.89	44.61	41.53
32	Jersey				53.31	44.18	49.97	69.41
33	Jersey				22.43	41.68	52.00	59.21
34	Jersey				22.91	24.36	59.89	73.30
Average		42.56	26.95	32.68	28.34	37.71	49.74	68.67
Grand Average		44.47	29.21	32.67	28.48	35.45	48.07	63.01

TABLE II

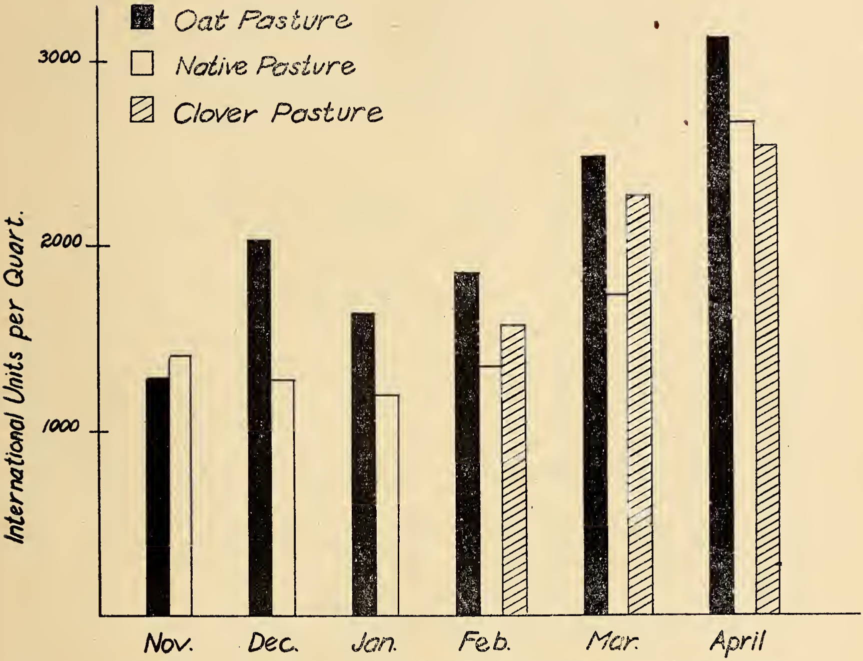
Vitamin A Potency of Creamery Milk

Coop. No.	October I.U.(1) qt.	October I.U.(2) g.b.f.	November I.U. qt.	November I.U. g.b.f.	December I.U. qt.	December I.U. g.b.f.	January I.U. qt.	January I.U. g.b.f.	February I.U. qt.	February I.U. g.b.f.	March I.U. qt.	March I.U. g.b.f.	April I.U. qt.	April I.U. g.b.f.
23	1118	30.96	1401	27.03	832	18.28	1373	28.69	1193	27.06	2287	56.95	2833	70.49
24	1489	43.50	730	16.38	763	16.43	1020	22.70	1273	35.18	1556	37.62	2516	58.34
25	2011	59.28	932	30.82	1173	35.35	831	26.99	781	28.04	1547	45.37	2040	57.10
27	1852	33.37	1169	25.79	1192	21.11	997	21.05	1637	37.97	1781	43.92	2314	63.98
28	1091	30.65	1102	29.38	903	23.66	764	19.78	866	24.87	1760	45.95	2675	69.98
29	1973	52.41	626	17.32	1365	36.78	1280	35.84	1905	57.25	3079	85.12	2662	78.74
Average	1589	41.69	993	24.45	1038	25.27	1044	25.84	1276	35.06	2002	52.49	2507	66.44

Creamery Butter

	I.U.(3) lb.	I.U. g.b.f.	I.U. lb.	I.U. g.b.f.	I.U. lb.	I.U. g.b.f.	I.U. lb.	I.U. g.b.f.	I.U. lb.	I.U. g.b.f.	I.U. lb.	I.U. g.b.f.	I.U. lb.	I.U. g.b.f.
30	16450	44.97	9821	24.89	9391	24.70	8235	22.63	12254	33.36	23157	62.59	20603	56.00
31	14510	41.72	9526	27.00	11085	31.14	7918	21.93	9839	28.85	11493	34.38	19278	55.90
Average	15480	43.34	9673	25.94	10238	27.92	8076	22.28	11046	31.10	17325	48.48	19940	55.95

(1) International Units per quart.
(2) International Units per gram of butterfat.
(3) International Units per pound.



Effect of Pasture on Vitamin A Potency of Herd Milk.

Fig.1

TABLE III

Effect of Supplemental Oat or Rye Pasture upon Vitamin A Potency of Milk
Oat & Rye pasture indicated by Italic faced type

Coop. No.	Breed	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	Remarks
1	Jersey	2913 56.22	2185 43.02	1148 25.83	1170 24.96	1060 40.07	*2098* *45.41*	*2824* *65.46*	On excellent pasture, improved with clover, and supplemental rye grass for 32 days before March sample taken. Continued excellent in April.
2	Jersey	1692 34.62	1570 29.77	*1908* *36.53*	*1428* *27.27*	*1417* *29.81*	*2291* *44.26*	*3267* *68.75*	Oat Pasture Dec. 1st to 19th. Sampled Dec. 5th. During Jan. & Feb. oat and vetch during day; at night limited grazing natural pasture containing clover.
8	Jersey	1596 46.68	*1022* *25.47*	*2235* *41.59*	1114 27.15	2337 51.87	3673 69.34	3192 68.50	Grazed 10 of 30 cows on oats one week, ten days before sample taken in Nov. During Dec. all of herd on oat pasture 5 days.
9	Holstein	1205 56.18	397 14.05	*1710* *47.41*	695 26.38	1861 58.61	2584 33.28	2817 104.81	*Grazed on oat pasture 5 days in Dec.
10	Jersey	2561 47.66	*1466* *27.22*	1876 34.26	1745 35.72	2807 51.18	*3257* *55.43*	*3683* *68.33*	Oat pasture Nov. 9th to Nov. 21st, sampled Nov. 27. Grazed on natural pasture and supplemental oat pasture March and April
11	Holstein	1444 41.74	*879* *31.57*	1364 37.74	1157 25.41	1899 48.97	*2493* *61.41*	*3028* *86.00*	Oat pasture Nov. 9th to Nov. 21st, sampled Nov. 27. Grazed on natural pasture and supplemental oat pasture March and April.
10 A	Jersey			*2144* *39.90*	*1862* *31.74*				Oat Pasture Nov. 9-21st, Nov. 29th to Dec. 15th sampled Dec. 10 and Jan. 16th.
11 A	Holstein			*1582* *58.99*	*1224* *33.46*				Same remarks as for 10A.
10 B	Jersey				*1514* *27.85*	*2988* *50.97*			Grazed on oat pasture 2 hours each morning; then in feed lot rest of day, beginning Jan. 21st. Sampled Jan. 30 and Feb. 16th.
11 B	Holstein				*1228* *36.45*	*2015* *54.79*			Same remarks as for 10B.

Coop. No.	Breed	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	Remarks
13	Holstein		1387 32.71	1180 34.10	1471 30.77	1275 40.16	1728 50.55	*2775* *79.96*	Excellent clover and Italian rye grass in April.
14	Jersey		1999 34.96	1895 37.69	1754 32.98	1366 27.37	2214 46.10	*3932* *71.10*	Excellent clover and Italian rye grass in April.
15	Holstein		1272 32.64	778 23.47	960 26.17	1217 27.91	*1849* *56.41*		Excellent clover and Italian rye grass for March.
16	Jersey		1904 30.51	898 15.72	936 17.07	1278 21.76	*2706* *50.22*	*2397* *47.07*	Excellent clover and Italian rye grass for March and April.
17	Jersey	2351 60.13	*1187* *29.98*	*2459* *49.83*	*1287* *25.26*	*1504* *31.35*	*2840* *49.43*	*3334* *65.40*	Oat pasture one week before sampled Nov. 29th. On oat pasture to Dec. 13th, sampled Dec. 15th. On oat pasture only 2 days before Jan. sample taken. For Feb. on oat 3 days and rye grass and clover 15 days before sampling. March and April rye grass, oat and clover.
21	Jersey	2517 49.13	*1821* *51.11*	*2399* *62.97*	*1185* *39.11*	*1428* *44.23*	*2585* *67.73*	3232 88.07	Grazed on oat pasture Nov. & Dec. In Jan. on oat pasture 3 days before sample taken on 28th, then on oats continuously until March 5th, then clover. Samples Feb. 9th and March 5th.
22	Guernsey	2558 52.75	1581 28.66	*1886* *41.48*	*2130* *39.75*	*1758* *30.91*	*2633* *47.07*	3130 91.22	Oat pasture one hour per day for 10 days before Dec. sample taken Continued to Dec. 28th. Sample Jan. 3rd. Returned to oat pasture after Feb. sample taken; continued thru March with clover pasture also.
32	Jersey				*2667* *53.31*	*1667* *44.18*	*1884* *49.97*	*2431* *69.41*	Grazed on oat pasture 1 1/2 hour per day. Clover showing a little in Feb. excellent March and April.
Average	Oat Pasture		1275 33.07	2040 47.21	1614 34.91	1825 40.92	2462 52.73	3075 69.05	Herds on oat or Italian Rye grass pastures.
Average	All others	1987 44.47	1360 28.07	1260 27.44	1165 26.36	1407 35.28	2018 44.74	2633 66.27	Herds on native or improved pasture — no oat pastures
Increase				780	449	418	444	444	

Upper figures — International Units per quart.
Lower figures — International Units per gram of butterfat.

TABLE IV

Effect of Clover upon the Vitamin A Potency of Milk

Clover supplemented native pasture indicated by Italic faced type

Coop. No.	Breed	January I.U. qt.	January I.U. g.b.f.	February I.U. qt.	February I.U. g.b.f.	March I.U. qt.	March I.U. g.b.f.	April I.U. qt.	April I.U. g.b.f.
3	Jersey	968	17.96	1397	24.18	1526	30.55	*2023*	*43.90*
4	Holstein	510	24.23	724	17.59	1072	29.57	*1507*	*46.64*
6	Jersey	924	20.13	646	17.62	1353	30.43	*2426*	*45.88*
7	Jersey	1017	31.16	1608	44.99	*2102*	*49.61*	*3345*	*63.26*
8	Jersey	1114	27.15	*2337*	*51.87*	*3673*	*69.34*	*3192*	*68.50*
9	Holstein	695	26.38	*1861*	*58.61*	*2584*	*33.28*	*3817*	*104.81*
13	Holstein	1471	30.77	*1275*	*40.16*	*1728*	*50.55*	2775*	79.96*
14	Jersey	1754	32.98	*1366*	*27.37*	*2214*	*46.10*	3932*	71.10*
15	Holstein	960	26.17	*1217*	*27.91*	1849*	56.41*		
16	Jersey	936	17.07	*1278*	*21.76*	2706*	50.22*	2397*	47.07*
18	Mixed	1256	27.65	1665	42.87	*1766*	*35.87*	2306	56.72
20	Holstein	984	35.35	1083	35.77	*1966*	*62.92*	*2404*	*74.63*
33	Jersey	877	22.43	1060	41.68	*2011*	*52.00*	*2404*	*59.26*
34	Jersey	1164	22.91	1085	24.36	2757	59.89	*3020*	*73.30*
Average	Clover pasture			1556	37.94	2255	49.96	2519	64.46
Average	Native pasture only	1194	26.33	1339	31.74	1701	37.77	2651	55.81

* Clover and Italian Rye grass, not included in average for clover pasture.

TABLE V

Comparison of the Vitamin A Content of Louisiana Milk with that of Milk Produced in Other Regions

Location		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
Louisiana Herd Milk	1943-44	1987	1358	1519	1280	1438	2203	2805
Louisiana Dairy Milk		1589	933	1038	1044	1276	2002	2507
Louisiana Herd Milk Supplemental Oat Pasture		——	1275	2040	1614	1825	2462	3075
Alabama Herd Milk Permanent Pasture	1939-40	1773	1500	1200	840	667	1007	1433
Alabama Herd Milk With supplemental rye and clover pasture		——	——	——	——	2733	3350	3467
Arizona Herd Milk Permanent Pasture	1943-44	1682	2068	1552	1279	1739	1852	——
Arizona Herd Milk Hay and silage		1060	889	861	948	1012	1086	——
Wisconsin Market Milk	1938-39	1997	1802	1383	1232	1144	992	984
Wisconsin Vitamin D Milk		1793	1900	1391	1279	1230	971	959
Wisconsin Guernsey Milk		2578	2378	1498	1509	1272	1120	1061
Wisconsin Certified Milk		1906	1970	1650	1312	1415	1278	1330

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FATTENING STEERS ON CORN, RICE PRODUCTS, AND RICE STRAW

By

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In cooperation with Swift and Co., Lake Charles, Louisiana

LOUISIANA STATE UNIVERSITY

AND

AGRICULTURAL AND MECHANICAL COLLEGE

AGRICULTURAL EXPERIMENT STATIONS

W. G. Taggart, *Director*

SUMMARY

1. Rations composed principally of rice by-products produced good gains on fattening steers. Due to high price levels on rice feeds the profits from feeding these were not as great as from feeding a corn and cottonseed meal ration. The relative values for the rice products compared to corn in these tests were not as high when fed to steers as when fed in mixed rations to swine or poultry. Rice bran and polish might have shown higher values if combined with other feeds, with some other roughage than rice straw.

2. Rice polish ranked second to corn as a fattening concentrate, with a feeding value of 86% to 89% that of corn, considerably less than its value in fattening swine. A small reduction in the price of rice polish would have made rice polish as profitable as corn. Rice polish might preferably be fed in combination with other concentrates, rather than as the only carbohydrate concentrate.

3. Ground rough rice produced satisfactory gains but should sell at 84% to 86% the price of corn to be a profitable stock feed. Where rough rice costs more than corn it is too expensive to feed at a profit.

4. Chicken-feed rice showed an estimated value of 70% to 72% that of corn. It might have been more satisfactory if ground. Chicken-feed rice has shown a much higher value when fed to lambs.

5. Rice bran, when used as the only carbohydrate concentrate, was not entirely satisfactory for fattening steers, showing a value of only 64% to 68% the value of corn. Steers fed principally on rice bran sold for the lowest prices per 100 pounds, and made the lowest gains per day. Rice bran showed to better advantage in combination with corn or molasses. Its greatest advantage is its low price compared to corn.

6. Rice straw, supplemented with a small amount of alfalfa hay and ground oystershell was a more economical roughage than mixed legume and grass hay at the prices paid in 1942. The value of rice straw as a feed is generally underestimated. Good rice straw has about 9/10 the nutrients contained in good oat straw, and from 75% to 80% the digestible nutrients in some of the grass hays. If fed in dry lot, that is, without access to green forage, some well cured legume hay of good color will supply Vitamin A, which is necessary to good gains on fattening steers.

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In cooperation with Swift and Co., Lake Charles, Louisiana

Louisiana's rice production is confined largely to twenty parishes in the southern section of the state, but is only grown to any appreciable extent in about ten parishes in the southwestern part. These ten parishes produce 95% of the total rice grown. As a cash crop, rice ranks second only to cotton in the state, producing in 1943 an estimated cash return of over $42,000,000. The rice industry furnishes as by-products a supply of feeds such as rice bran, rice polish, rice screenings or fine broken particles of polished rice, chicken-feed rice which is largely broken rough rice removed in thrashing, and rice straw. In some years, certain grades of damaged rough rice are used for feeding. As more than 30% of the beef cattle of the state are produced in the ten parishes referred to above, the combination of rice products, rice straw, molasses and cattle makes this section a potential feeding area.

These experiments at Lake Charles were planned in 1939 by Dr. M. G. Snell, Associate Animal Husbandman, in cooperation with Swift and Company of Lake Charles, Louisiana, the cattle and feed being furnished by Swift and Company and supervision and labor furnished by the Louisiana Experiment Station. The experimental work was first in charge of Mr. F. L. Morrison, Research Assistant, given military leave in November 1940, and succeeded by Murl Jackson. Dr. Snell was called into military service in February 1941; was commissioned as Major in the fall of that year; sent to the Philippines in November of that same year, and made a prisoner of war at the fall of Bataan. C. I. Bray assumed charge of the work from the fall of 1941.

The Louisiana Experiment Station and the cattlemen of Louisiana are indebted to Swift and Company for providing the equipment and cattle which made this experimental work possible, and for the cooperation of the officials of the company at the Lake Charles Branch, particularly Mr. John T. Powell, former manager of the plant, V. A. Gilpin, present manager, and Robert T. Harper, superintendent and head buyer of the Swift stock yards.

TABLE I. Production of Rice in the United States and Louisiana in 1942 With Estimated Percentage of Mill By-Products

		United States	Louisiana
Rice production—bushels	------	66,333,000	25,758,000
barrels	------	18,426,000	7,155,000
Estimated By-Products	Per Cent	Tons	Tons
Rice bran	8.64	100,000	38,630
Rice polish	1.85	21,310	8,278
Brewers' rice	2.10	24,142	9,379
Rice screenings	3.10	35,650	13,950
Total other than rough rice	------	181,102	70,237
Chicken feed rice	0.5	7,100	2,759
Total feed products — tons	------	188,202	72,996

OFFICIAL DEFINITIONS OF RICE BY-PRODUCTS AS ADOPTED BY AMERICAN FEED CONTROL OFFICIALS*

Rice Bran is the pericarp or bran layer of the rice, with only such quantity of hull fragments as is unavoidable in the regular milling of rice.

Rice Polish is a by-product of rice obtained in the milling operation of brushing the grain to polish the kernel.

Rice Meal is ground brown rice or ground rice after the hull has been removed.

Ground Rough Rice is ground rice from which the hull has not been removed, or ground paddy rice.

Rice Stone Bran is the siftings from the materials secured in removing hulls from rice and contains rice germs, broken rice and some rice hulls.

Rice Huller Bran is a product secured by the huller and cones from brown rice and consists mostly of the bran and germs.

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* Reports of Analyses of Commercial Feed Stuffs. Season of 1939-40. Louisiana Department of Agriculture and Immigration.

FEED NUTRIENTS AND MINERALS IN RICE FEEDS

The following table, adapted from Morrison's **Feeds and Feeding**, 20th edition, shows the digestible nutrients of rice products compared with corn and other common feedstuffs.

TABLE II. Percentage of Protein, Total Nutrients, Fiber and Calcium and Phosphorus in Rice Feeds Compared to Other Common Feeds

	Per Cent Dry Matter	Per Cent Digestible Protein	Per Cent Fiber Total	Per Cent Digestible Nutrients	Mineral Elements	
					Calcium	Phosphorus
Rice polish	90.5	9.3	3.0	85.7	0.04	1.10
No. 1 corn	87.2	7.3	2.3	83.5	0.01	0.28
No. 3 corn	83.5	7.0	2.2	79.0	0.01	0.27
Brewers' rice	88.0	5.4	0.8	79.7	0.04	0.10
Wheat shorts	90.1	15.1	6.2	76.3	0.09	0.72
Wheat bran	90.6	13.1	9.5	70.2	0.12	1.32
Rice bran	91.1	8.8	13.0	67.7	0.08	1.36
Rice, bran, low grade	90.1	5.3	20.2	45.2	------	------
Rough rice	88.6	6.3	8.8	69.1	------	0.21

The Process of Milling

The work of the rice miller is to remove the hulls, germs, and outer seed coatings of the rice grain in such a way as to leave a high percentage of whole grains or head rice with a low percentage of broken grains, such as second heads, screenings, and brewers rice.

The rough rice is first put through a cleaning process to remove dirt, trash, long beards, stems, and light or blighted grains, and goes next to the hulling stones which crack or split the hulls. The mixture of partially hulled rice and hulls is then put through a revolving screen called the "stone reel" or a shaker called a "rotex", which separates out all fine particles of hulls, rice germs and true bran. This material is called "stone bran" which has a much larger percentage of fiber than huller bran. The loose hulls are removed by aspiration or screening and used as fuel. Any remaining unhulled grains are separated out by the paddy separator and passed through another set of huller stones to complete the hulling process.

The hulled brown rice goes next through the machines, incorrectly called "hullers", which remove the "huller bran", with which we are most familiar, which is removed by the first-break and second-break bran reels, or the rotex machine.

In a few mills the hulled rice may next be put through a "pearling cone" where a finer bran is removed, known as pearling cone polish or cone meal. This is sometimes sold separately, but may be mixed at some mills with the huller bran or mixed with the polish. The rice grains next go through the "brush" or polishing machine which removes the rest of the seventh coat or aleurone layer, together with some starch cells, producing a fine cream-colored floury material known as rice polish or polishings. This product contains very little fiber but more nutritive material than any other rice by-product. The polished rice then goes to the brewers reel which takes out the rice particles averaging less than one-quarter grain, known as brewers rice. The whole grains and larger broken parts will then go through the grading machines and are separated into head rice, second heads and rice screenings. Brewers rice is not used at the present time as stock feed but the lower grades of rice screenings are sometimes used.*

DISCUSSION OF RICE FEEDS

Rice Bran

Rice bran is the principal by-product of the rice milling industry. It is a low priced feed, medium in protein content, high in fat, and high in phosphorus but low in calcium. Rice bran contains about 84% as much calculated digestible nutrients as No. 2 corn. The bran proteins are of good quality and appear to supplement the proteins of corn in such a way that when corn and rice bran are fed together, the two proteins combined are more effectively utilized than where either is fed alone. Rice bran has a high fat content. In the early days there was considerable trouble with bran becoming rancid in hot weather, making it unpalatable to livestock. This has been largely overcome in modern mills by thorough drying of the rice before milling and also by kiln drying the rice bran to destroy the organisms which break down the fats, causing rancidity.

Since rice bran, like corn, is low in calcium (lime), animals on rations containing much rice bran should have a mineral supplement containing fine ground oystershell or ground lime stone.

Low-grade rice bran may contain large amounts of hulls. The percentage of fiber will indicate the proportion of hulls. According to Fraps (8) rice bran with 8% fiber contains little or no hulls, 10% fiber indicates about 6.4% hulls, and 15% fiber indicates over 20% hulls. Rice bran to be sold as such in Louisiana must contain not more than 12% fiber. The better grades of rice bran average 9% fiber. In buying rice bran it is important to see that it has been inspected and tagged, with a guaranteed analysis.

Rice Polish

Rice polish is a concentrated and highly digestible feed of fine texture, quite palatable to livestock. Very low in fiber, it contains more protein and fat than corn and a higher percentage of digestible nutrients. The proteins of rice polish are better balanced than the proteins of corn (13). Rice polish should be considered as a fattening feed rather than a protein concentrate. Because it is so highly concentrated, and of such fine texture, it is particularly suitable for feeding in mixtures with other feeds.

Rough Rice

During some seasons a certain amount of rice is damaged by rain so that it brings a relatively low price compared to high grade rice. This damaged rice is frequently used in the rice area for feeding dairy cattle, mules, hogs and poultry. The presence of red rice lowers the market value of the rice but probably does not affect the feeding value. When there is a strong demand for rice, as at present, low grade rice does not sell sufficiently below corn prices to be profitable as feed. Rough rice for feeding should be ground sufficiently so that the hulls are made into a meal.

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* *Rice and Rice By-products for Swine.* La. Agr. Exp. Sta. Bul. 386.

Chicken-Feed Rice

Chicken-feed rice is made up of particles of broken rough rice removed in threshing, together with weed seeds, grass seeds, dirt and other foreign materials. The percentage of rice grain will vary considerably. There is only a limited amount of this material, and practically all of it is fed locally. The feed value will depend almost entirely on the percentage of sound broken rice contained. One sample analyzed contained 86% rice grain; 8.8% dirt or inert matter; and 5.2% grass and weed seeds. If rough rice is worth 88% as much as corn, then chicken-feed rice containing 86% rice grain would be about equal to 75% its weight of corn, which checks closely with the 73% value reported in these tests. Chicken-feed rice should probably be ground for feeding cattle.

Rice Screenings and Brewers Rice

Rice screenings and brewers rice are the broken parts of milled rice grain separated during milling and polishing. A barrel of rice produces about 26 pounds of broken rice, graded according to size into approximately 9 pounds of second-head milled rice, 12 pounds screenings-milled rice, and 5 pounds brewers rice, depending on the milling. Second head rice and high grade screenings are used almost entirely for human consumption or for the manufacture of rice flour and rice paste. Brewers rice, which is the smaller particles of broken rice, is now used almost entirely in the brewing industry. Only the lower grades of screenings are used for stock feed. Screenings and brewers rice are approximately equal in value for feeding. Brewers rice or rice screenings used in comparison with corn in pasture feeding experiments with steers in 1932 proved to be practically equal to corn (3).

Rice Straw

Steers fed rice straw as the principal roughage made good gains; where fine-ground oystershell was provided to supply calcium and with a small amount of good green colored alfalfa hay to supply Vitamin A.* The rice straw showed a feeding value approximately equal to one third its weight of legume hay; but was more profitable than hay at 1941 feed prices. Analyses show that rice straw is not greatly lower in nutrients than oat straw, or cottonseed hulls.

Percentage Composition and Digestible Nutrients in Straws, Hay and Hulls

	Digestible Protein	Total Dig. Nutrients	Total Fiber	Total Fat	Total — Nitrogen Free Extract (Soluble carbohydrates)
Oat Straw	0.9	44.1	36.1	2.3	41.2
Wheat Straw	0.8	35.7	35.7	1.5	40.9
Rice Straw	0.9	39.4	33.5	1.4	39.2
Cottonseed hulls	0.8	43.7	46.6	0.9	36.7
Sudan grass hay	4.3	48.5	27.9	1.6	42.9

Some rice straw will naturally be of more value than other straw depending on the stage at which the rice is cut and the amount of rainfall and exposure to weather after cutting, and how well it has been protected in the stack.

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* Vitamin A, found principally in green grass, green colored legume hay, yellow corn, carrots, yellow sweet potatoes, silage, etc. is the vitamin which protects against night blindness. It is absent in straw, cottonseed meal, cottonseed hulls, and in the cereal grasses and cereal by-products, aside from yellow corn and yellow corn products. Experiments at the Texas (Spur) Station have shown that one pound of high quality green colored alfalfa hay per day prevented blindness in calves fed a Vitamin A deficient ration for a period of 502 days while those not fed this hay went completely blind in 139 days. (Proceedings of the American Society of Animal Production. 1938)

Rice Hulls

There has been some interest in the possibility of using rice hulls as feed. In the early days some millers were accustomed to mix various amounts of ground rice hulls with the rice bran, and with other feeds. While there is a small amount of feed value in ground rice hulls, there is no evidence to show any noticeable advantage in their use. The principal objection to ground rice hulls is their use in adulterating other feeds and their inclusion in such feed mixtures as the molasses feeds or so called "sweet" feeds, and other mixed feeds. Ground rice hulls are hard to distinguish from some good mill feeds except on microscopical examination. The feeding value is at best so low that even for the maintenance of stocker cattle ground hulls are worth less than low grade straw. Early tests at the Texas station showed that rice hulls had little or no value. In a recent test at the Texas station, 1938, J. M. Jones and others (10) reported that finely ground rice hulls even when fed in small quantities to fattening steers, replacing cottonseed hulls, reduced gains, increased cost of gains, and decreased the sale value of the cattle.

EARLY INVESTIGATIONS ON RICE FEEDS

One of the earliest records regarding the feeding of rice products in Louisiana is found in La. Exp. Sta. Bul. 34 (18) published in 1895, by Director W. C. Stubbs and D. N. Barrow, and in a later bulletin, Rice (19), published by W. C. Stubbs, W. R. Dodson and C. A. Browne, Jr. in 1904. These reports indicated that the rice by-products were being used to some extent as cattle feed in these days, although the feeding trials reported in these bulletins were simple digestion trials only. The rice bran used in 1895 was reported to contain 16%

rice hulls and 25% grits (brewers rice) and had an apparent digestibility of 61.5% compared to 84.6% for rice polish. Previous to 1880 rice bran had been an unsaleable product and was given away by the mills. Browne reports that the analyses of rice products in Louisiana were begun at the Audubon Sugar Experiment Station (Louisiana) in 1887 at which time attention was called for the first time to the feeding value of these products. Pure rice bran was then sold as "rice meal" and was considered to be the most nutritious of the rice feeds. Commercial rice bran was at that time a mixture of bran and ground rice hulls, the quantity of the latter being any amount from 20% to 70%. Rice hulls were often ground separately and sold as "husk meal" or "star bran". Large amounts of rice polish and rice bran were exported to Germany. Rice grits, now known as brewers rice, was frequently mixed with the rice polish and rice bran. In those days there was considerable trouble from rancidity in rice bran if kept any length of time. Due to this rancidity rice bran was reported as unpalatable and was usually mixed with cottonseed meal in feeding. It was recommended that millers should heat their bran to 200° F or higher in order to prevent rancidity.

Some of the earliest work reported on feeding rice bran to beef cattle was conducted at the Texas Station. An early report by Craig and Marshall (5) in 1903 stated that three pounds of rice bran replaced two pounds of cottonseed meal in fattening rations, increased gains, and lowered costs per pound gain. Rice polish also increased gains and lowered costs, when added to a meal and hulls ration.

EXPERIMENTS WITH RICE PRODUCTS AND ROUGH RICE AT OTHER STATIONS

Rough Rice

Craig and Marshall (6), Texas, 1906, reported feeding steers ground rough rice with cottonseed meal, cottonseed hulls and hay. The gains were satisfactory although the costs were higher where ground rough rice was used. Cruse (7) at the same station reported that ground rough rice added to cottonseed meal and hulls produced higher gains but not cheaper gains. Whole rough rice produced scours and bloating.

Weaver and Moffett (21), Missouri Station, fed ground rough rice in comparison with corn in fattening steers. They reported that ground rough rice was palatable to cattle but was worth only 76.3% as much as shelled corn. The gains produced on rough rice were 15.6% lower than with corn.

Rice Bran and Rice Polish

Knox and others (14), Texas, substituted 3.85 pounds of rice bran for part of the ground milo and cottonseed in a steer fattening ration. They reported increased gains and lower costs per pound gain when rice bran cost $9.00 per ton and ground milo $13.10. One ton of rice bran replaced 2,131 pounds of ground milo, 175 pounds cottonseed meal and 700 pounds of hay. The rice bran amounted to 20% of the concentrate ration. The gains were increased .21 pounds per day and the net profits increased $3.26 per steer. Evidently the rice bran made a good supplement to ground milo.

Jones and others (9), Texas, 1935, fed rice bran at three different levels replacing part of a ration of ground shelled corn, cottonseed meal, alfalfa hay and grass hay. The rice bran replaced respectively 25%, 40% and 50% of the corn in the various rations. The lot receiving 25% rice bran made the highest gain per day — 2.30 pounds as compared to 2.11 pounds for the ration of corn alone, 2.19 pounds for the lot receiving 40% rice bran and 2.17 pounds for the lot receiving 50% rice bran. Rice bran at $30.00 per ton was more profitable than corn at $37.20 per ton, or cottonseed meal at $42.00 per ton. The lot receiving 25% bran sold for the highest price — 40c above the corn lot — and made the greatest profit per head. Those receiving 50% bran graded the lowest and made a profit very little above corn and cottonseed meal.

RICE PRODUCTS FOR FATTENING CATTLE

The experiments reported in this bulletin were conducted in cooperation with Swift and Company at the Swift plant near Lake Charles. Swift and Co. provided the feeding plant, which is equipped with storage rooms for feed and with six feeding pens with concrete floors, partly covered by a shed roof. Swift and Co. also supplied the cattle and feed. Labor and supervision were furnished by the Louisiana Experiment Station. Until March, 1941, the experimental work was in charge of Dr. M. G. Snell, assisted by F. L. Morrison and M. Jackson.

EXPERIMENT I — 1938-39

COMPARISONS OF CORN, GROUND ROUGH RICE, CHICKEN-FEED RICE, RICE POLISH AND RICE BRAN IN RATIONS FOR FATTENING STEERS

Object of Test:

To obtain information on the relative feeding value of ground rough rice, chicken-feed rice, rice polish, and rice bran, when fed with rice straw as roughage and with cottonseed meal as the protein supplement. A check lot, Lot 1, was fed a ration of corn, cottonseed meal, and rice straw.

Cattle Used 1939:

A mixed group of Hereford, Angus, and native steers weighing approximately 505 pounds each; 10 steers to the lot.

Concentrate Rations:

Lot 1. Corn[12], cottonseed meal[4].
Lot 2. Ground rough rice[12], cottonseed meal[4].
Lot 3. Chicken-feed rice[12], cottonseed meal[4].
Lot 4. Rice polish[12], cottonseed meal[4].
Lot 5. Rice polish[6], rice bran[6], cottonseed meal[4].
Lot 6. Rice bran[12], cottonseed meal[4].

TABLE III. Rice Products As Feeds For Fattening Cattle
Sept. 28, 1938 to Jan. 1939 — 112 days

Lot No.	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Gr. Rough Rice 12 C. S. Meal 4	Chicken Feed 12 Rice C. S. Meal 4	Rice Polish 12 C. S. Meal 4	Rice Bran 6 Rice Polish 6 C. S. Meal 4	Rice Bran 12 C. S. Meal 4
Ave. Initial Weight	507	502	507	505	506	506
Ave. Final Weight	791	768	742	775	735	722
Ave. Gain, Lbs.	285	266	236	270	229	216
Ave. Daily Gain, Lbs.	2.54	2.38	2.10	2.41	2.05	1.9
Average Daily Feed, Lbs.						
Concentrates	14.8	14.8	14.8	14.8	14.8	14.8
Alfalfa	.35	.35	.35	.36	.35	.35
Rice straw	3.37	3.61	5.38	3.92	3.45	4.01
Powdered oystershell	.1	.1	.1	.1	.1	.1
Salt	.011	.009	.006	.02	.014	.026
Feed required per 100 Lbs. gain						
Corn	437.3					
Rough rice		468.1				
Chicken-feed rice			528.7			
Rice polish				462.0	271.5	
Rice bran					271.5	577.5
Cottonseed meal	145.7	156.0	176.3	154.0	181.0	192.5
Alfalfa	14	15	17	15	17	18
Rice straw	133	148	256	162	168	208
Feed cost per 100 lbs. gain	$ 8.56	$ 9.05	$ 8.95	$ 7.14	$ 7.45	$ 6.93
Ave. cost per steer	27.60	27.33	27.60	27.51	27.54	27.58
Ave. feed cost	24.40	24.07	21.08	19.26	17.10	14.94
Total cost of steer	52.00	51.40	48.68	46.77	44.64	42.52
Sale value per cwt.	8.27	8.24	7.95	8.41	7.64	7.51
Ave. sale value per steer	66.43	63.25	58.99	65.17	56.15	54.20
Profit or loss	14.43	11.85	9.59	18.40	11.52	11.68

FEED PRICES: Corn — $1.48, Ground rough rice — $1.45, Chicken-feed rice — $1.21, Rice polish — $1.06, Rice bran — $ .72, Cottonseed meal — $1.14, per cwt., Rice straw — $3.50, and Alfalfa hay — $28.20 per ton.

Roughage and Minerals

The roughage used was rice straw, supplemented with one feed of good green alfalfa hay every two weeks (about 6 pounds per steer) as a source of Vitamin A. One-tenth of a pound of powdered oystershell per steer per day was fed in the feed mixture.

The cattle were started on 4 pounds of feed mixture daily and gradually increased to 16 pounds daily. The racks were kept full of straw at all times. Cottonseed meal was fed with the rice products at the rate of 25% of the concentrate ration.

Results

At the end of the test the cattle were slaughtered at the Swift plant and the dressing percentage, carcass grades, and slaughter values recorded for each lot. The rate of gain, feed consumption, feed per 100 pounds gain, and sale values are given in Table III.

Lot 1, on corn, made the greatest gain with the least feed required per unit of gain. Lot 4, on rice polish, made the next highest gains and was also very efficient in regard to feed consumed per 100 pounds gain. Lot 2, on ground rough rice, ranked next to rice polish. Lot 6, fed rice bran, made the lowest gains. Lot 3, fed chicken-feed rice, made the lowest profit on account of the relatively high price of chicken-feed rice, but the gains were satisfactory.

Using the feed requirement per unit of gain as a measure of value with corn considered as 100 per cent, rice polish was 95 per cent as valuable as corn, ground rough rice 93.7 per cent, chicken-feed rice 83.1 per cent, equal parts of rice polish and rice bran 81 per cent, and rice bran 76 per cent the value of corn, not considering any differences in the amount of straw eaten.

Slaughter Data

Table IV gives the slaughter data of the various lots, such as dressing percent, grade of carcass and value per 100 pounds live weight, based on carcass value.

TABLE IV. Comparison of Slaughter Value, Carcass Grade, and Dressing Per Cent of Cattle Fed Different Rations, 1938-39

Lot	Ration	Average Daily Gain, Lbs.	Dressing Per Cent	Carcass Grade	Slaughter Value Per 100 Lbs. Live Wt.
1	Corn	2.54	54.42	3.6	$8.27
2	Rough rice (ground)	2.38	54.74	3.4	8.24
3	Chicken-feed rice	2.10	53.82	4.0	7.95
4	Rice polish	2.41	55.16	3.7	8.41
5	Rice polish—½ Rice bran—½	2.05	53.06	4.3	7.64
6	Rice bran	1.90	52.60	4.4	7.51

The grading scale used by Swift and Company in this test begins at zero (0) for the highest or prime grade and continues in numerical order to six (6) the lowest or canner grade. Consequently a grade of 3.4 (Lot 2) is a full grade higher than a grade of 4.4 (Lot 6). Lot 2, fed rough rice, graded slightly the highest (3.4) followed by the corn lot, then the rice polish lot, then chicken-feed rice, rice polish-rice bran combined, and lastly rice bran alone. The experimental lots that made the most rapid gains naturally had the highest finish and the best carcass grades.

Financial Record

Table V shows the initial cost of cattle and feed, sale value per 100 pounds, and the sale price necessary to break even for each lot. Generally speaking the fastest gaining lots produced the best profits, but this depends also on the prices of feeds. The object in feeding is to make money, which does not necessarily mean the greatest gain, but the greatest spread between costs and sale value. The rice polish lot (Lot 4) made somewhat the best profit, followed in order by corn, then ground rough rice, rice bran, rice polish and rice bran combined, with chicken-feed rice last. Rice polish was bought at a much lower price than corn in this test which explains the larger profits on the polish-fed cattle.

TABLE V. Financial Statement — 1939

Lot	1	2	3	4	5	6
	Corn	Rough Rice	Chicken-feed Rice	Rice Polish	Polish and Bran	Rice Bran
Initial cost per cwt.	$ 5.45	$ 5.45	$ 5.45	$ 5.45	$ 5.45	$ 5.45
Sale value per cwt.	8.27	8.24	7.95	8.41	7.64	7.51
Necessary price to break even	6.92	6.98	7.34	6.40	6.45	6.28
Initial cost	27.60	27.33	27.60	27.51	27.54	27.58
Feed	24.40	24.07	21.08	19.26	17.10	14.94
Labor	2.80	2.80	2.80	2.80	2.80	2.80
Total cost per head	54.80	54.20	51.48	49.57	47.44	45.32
Sale value per head	66.43	63.25	58.99	65.17	56.15	54.20
Profit	11.63	9.05	6.79	15.60	8.72	8.88

How Breeding and Quality Affects Gains and Prices

Each feeding pen contained seven steers that graded good as feeders and three which graded common. Table VI shows the relationship between feeder grade, gains, and final value. It would not be possible to show relative profits without knowing the amount of feed eaten by each of the two grades.

TABLE VI. Gains and Slaughter Data of Good and Common Cattle

	Good Grade	Common Grade
Initial weight, average	545.5 lbs.	411.1 lbs.
Final weight	799.6 lbs.	654.2 lbs.
Gain	254.1 lbs.	243.1 lbs.
Daily gain	2.27 lbs.	2.16 lbs.
Dressing percentage	54.42%	51.96%
Feeder price per cwt.	$ 5.35	$ 4.25
Feeder price per head	$29.18	$17.47
Finish price per cwt.	$ 8.28	$ 6.22
Finish price per head	$66.20	$40.69
Increase in price per 100 lbs. during test	$ 2.93	$ 1.97
Increased value per head	$37.02	$23.22

The common steers made nearly the same gains as the good steers, and showed a good increase in value over feeder cost. The good steers showed a higher dressing percentage, a higher carcass grade and a greater spread between feeder price and finished price than did the common steers.

EXPERIMENT II — 1939

COMPARISONS OF CORN, GROUND ROUGH RICE, CHICKEN-FEED RICE, RICE POLISH AND RICE BRAN

Cattle Used

Sixty-six yearling steers of mixed breeding were divided equally according to weight, breeding and condition. The average weight was 455 pounds.

Concentrate Rations

Lot 1. Corn[12], cottonseed meal[4].
Lot 2. Ground rough rice[12], cottonseed meal[4].
Lot 3. Chicken-feed rice[12], cottonseed meal[4].
Lot 4. Rice polish[12], cottonseed meal[4].
Lot 5. Rice polish[6], rice bran[6], cottonseed meal[4].
Lot 6. Rice bran[12], cottonseed meal[4].

Roughage and Minerals

Rice straw was fed in self-feeder racks as before and was supplemented with a feed of alfalfa once every two weeks to supply Vitamin A. Fine-ground oystershell was fed with the concentrate ration at the rate of one-tenth pound per steer daily.

The cattle were started on 4 pounds of concentrates daily and gradually increased until the steers were consuming 20 pounds per day.

TABLE VII. Rice and Rice Products As Feeds For Fattening Cattle
September 8 to December 12, 1939 — 112 days — 11 steers per lot

Lot No.	1	2	3	4	5	6
Concentrate Ration	Gr. Corn 12 C. S. Meal 4	Gr.Rough Rice 12 C. S. Meal 4	Chicken-feed Rice 12 C. S. Meal 4	Rice Polish 12 C. S. Meal 4	Rice Polish 6 Rice Bran 6 C. S. Meal 4	Rice Bran 12 Cottonseed Meal 4
Ave. Initial Weight	459	454	455	455	453	456
Ave. Final Weight	720	666	674	694	657	661
Ave. Gain, Lbs.	261	212	219	239	198	205
Ave. Daily Gain, Lbs.	2.33	1.89	1.95	2.14	1.78	1.83
Average Daily Feed, Lbs.						
Concentrates	15.16	15.16	15.16	15.16	15.16	15.16
Alfalfa	.19	.19	.19	.19	.19	.19
Rice straw	3.52	3.63	4.44	3.95	3.45	3.28
Powdered oystershell	1	.1	.1	.1	.1	.1
Salt	.02	.02	.01	.01	.02	.02
Feed required per 100 lbs. gain						
Corn	488.25					
Rough rice		601.5				
Chicken-feed rice			581.3			
Rice polish				531.7	321.3	
Rice bran					321.3	622.5
Cottonseed meal	162.75	200.5	193.7	177.3	214.3	207.5
Alfalfa hay	8.2	10.1	9.8	8.9	10.8	10.4
Rice straw	151.0	192.0	227.0	185.0	195.0	180.0
Powdered oystershell	4.3	5.3	5.1	4.7	5.7	5.5
Salt	.7	.9	.6	.6	1.3	1.1
Feed cost per 100 lbs. gain	$10.83	$16.30	$11.89	$11.09	$12.02	$10.29
Ave. cost per steer	26.85	26.54	26.60	26.62	26.50	26.62
Ave. feed cost per steer	28.26	32.37	26.02	26.53	23.83	21.05
Total cost of steer	55.11	58.91	52.62	53.15	50.33	47.67
Sale value per cwt.	$ 8.25	$ 8.00	$ 7.25	$ 8.00	$ 7.75	$ 7.25
Ave. sale value per steer	59.40	53.28	48.84	55.52	50.47	47.90
Profit or loss per steer	4.29	-5.63	-3.78	2.37	.14	.23

FEED PRICES: Corn — $1.54, Ground rough rice — $1.86, Chicken-feed rice — $1.34, Rice polish — $1.40, Rice Bran — $ .98, Cottonseed meal — $1.69, Alfalfa — $ .90, Rice straw — $ 0.30, Oystershell — $ .50, Salt — $ .35 per cwt.

Results

As in the previous experiment the cattle were slaughtered by Swift and Company and records made of the dressing percent, carcass grade, and sale value per 100 pounds weight. Detailed results regarding rate of gain, feed consumption, feed per 100 pounds gained, etc. are given in Table VII. As in the previous trial the steers receiving ground shelled corn made the most rapid and economical gains, and again the rice polish group (Lot 4) was second in gains and in profits. However, in this trial Lot 3, fed chicken-feed rice. made faster gains than did the lot fed ground rough rice and Lot 6, fed rice bran as the principal carbohydrate feed, made slightly better gains than those fed a mixture of polish and bran. This result does not check with the results of other years and was evidently due to some difference in the cattle.

Slaughter Data

Table VIII gives the dressing percentage, average carcass grade, and slaughter value of the steers in the various lots.

TABLE VIII. Gains, Dressing Percentage, Carcass Grade and Slaughter Value of Steers Fed on Rice and Rice Products. 1939.

Lot	Ration	Daily Gain Lbs.	Dressing Per Cent	Average Carcass Grade*	Slaughter Value Per 100 Lbs.**
1	Ground corn	2.33	56.9	14.1	$8.25
2	Ground rough rice	1.89	55.7	14.5	8.00
3	Chicken-feed rice	1.95	55.4	14.8	7.25
4	Rice polish	2.14	55.2	14.3	8.00
5	Rice polish — ½ Rice bran — ½	1.78	56.5	14.4	7.75
6	Rice bran	1.83	53.9	14.6	7.25

*Swift steer grades used in this test were as follows: 13—Select; 14—Swift; 15—Sanco.
**Based on carcass values.

The carcasses averaged medium in quality for each lot. There was a difference of $1.00 per 100 pounds in sale price between the corn lot, Lot 1, and Lots 3 and 6.

Relative Profits

The corn and rice polish lots were the only two groups which showed a fair profit, with the two rice bran lots apparently breaking even. The lots fed ground rough rice and chicken-feed rice showed a loss. This was not surprising since the ground rough rice cost 32 cents more per 100 pounds than corn. If rough rice has a feeding value of 82 per cent of that of corn, it must sell for 82 per cent the price of corn to show an equal profit for feeding. Chicken-feed rice, which has shown a value 72 per cent the value of corn, cost 87 per cent the price of corn and was fed at a loss.

TABLE IX. Rice and Rice By-Products For Fattening Cattle
September 13, 1940 to January 4, 1941 — 112 days
11 Steers Per Lot

Lot No.	1	2	3	4	5	6
Concentrate Ration	Gr. Corn 12 C. S. Meal 4	Gr.Rough Rice 12 C. S. Meal 4	Chicken-feed Rice 12 C. S. Meal 4	Rice Pol. 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 12 C. S. Meal 4
Ave. Initial Weight	411.8	409.8	413	411.6	413.4	411.0
Ave Final Weight	665.7	661.5	628	637.5	628.9	608.2
Ave. Gain, Lbs.	253.9	251.7	215	225.9	215.5	197.2
Ave. Daily Gain, Lbs.	2.26	2.24	1.91	2.01	1.92	1.76
Average Daily Feed, Lbs.						
Concentrates	15.16	15.16	15.16	15.16	15.16	15.00
Alfalfa	.2	.2	.2	.2	.2	.2
Rice straw	2.5	3.85	4.44	2.93	3.67	3.46
Oystershell	.1	.1	.1	.1	.1	.1
Salt	.012	.011	.014	.015	.026	.018
Feed required per 100 lbs gain						
Corn	501.5					
Rough rice		505.9				
Chicken-feed rice			620.3			
Rice polish				563.7	295.5	
Rice bran					295.5	638.9
Cottonseed meal	167.1	168.6	206.7	187.9	197.0	212.9
Alfalfa	8.7	9.13	10.5	9.97	10.46	11.43
Rice straw	110.5	171.3	232.3	145.3	191.0	197.0
Feed cost per 100 lbs. gain	$10.56	$10.87	$11.44	$10.28	$10.01	$ 9.94
Ave. cost per steer	24.70	24.58	24.78	24.69	24.80	24.66
Ave. feed cost per steer	26.82	27.36	23.67	23.29	21.88	19.67
Total cost of steer	51.52	51.94	48.45	47.98	46.68	44.33
Sale value per cwt.	$ 8.47	$ 7.88	$ 7.41	$ 8.06	$ 7.56	$ 6.64
Ave. sale value per steer	56.38	52.12	46.53	51.38	47.54	40.38
Profit or loss per steer	4.86	.18	-1.92	3.40	.86	-3.95

Feed prices per 100 lbs ave: Ground shelled corn — $1.45, Ground rough rice—$1.42, Chicken-feed rice—$1.10, Rice polish—$1.15, Rice bran—$ .85.
Alfalfa hay — $1.10, Rice straw — $ .60, Oystershell — $ .50, Salt — $ .50.

Conclusion

The feeding value of rough rice given here checks closely with results obtained with swine and poultry by the Louisiana Station. Rice bran was not improved by mixing with rice polish and did not show as high a value for feeding steers as for swine (4).

EXPERIMENT III — 1940-41

COMPARISONS OF CORN, GROUND ROUGH RICE, CHICKEN-FEED RICE, RICE POLISH AND RICE BRAN FOR FATTENING STEERS

The cattle used were grade Angus yearlings weighing approximately 412 pounds; the feeds were the same as used in previous experiments, with no change in methods of feeding. The cattle were slaughtered and graded as in previous tests. The record of gains, daily ration, feed per 100 pounds gain and financial record are given in Table IX. Corn again proved the most profitable, with rice polish second. In this test, rough rice was priced a few cents lower than corn, and broke even on profits. Chicken-feed rice and rice bran were fed at a loss. The mixture of rice polish and rice bran showed up a little better than in 1939.

Table X gives the dressing percentage, carcass grade, and slaughter value per 100 pounds. The slaughter values were in accordance with the rate of gain as in previous tests, also in regard to dressing percentage and carcass grade.

TABLE X. Gains, Dressing Percentage, Carcass Grade, and Slaughter Value of Steers Fed Rice and Rice Products. 1940-41.

Lot	Ration	Daily Gain Lbs.	Dressing Per Cent	Average Carcass Grade*	Slaughter Value Per 100 Lbs.**
1	Ground Corn	2.27	56.9	13.8	$8.47
2	Ground Rough Rice	2.24	53.3	14.0	7.88
3	Chicken-feed rice	1.90	52.1	14.3	7.41
4	Rice Polish	2.01	55.3	14.0	8.06
5	Rice Bran — ½ Rice Polish — ½	1.92	53.3	14.5	7.56
6	Rice Bran	1.76	51.1	15.1	6.64

*Swift grades: 13 — Select; 14 — Swift; 15 — Sanco.

**Based on carcass values.

AVERAGE OF THREE EXPERIMENTS
1938-39, 1939-40, and 1940-41

Table XI gives the average weights, gains and feed consumption for the three years work, together with the margin of profit over feed cost. The results are largely the same as in the first test. The corn ration proved superior in gains and profits, followed next by rice polish. Ground rough rice ranked close to rice polish in rate of gain with chicken-feed rice next, followed by rice polish and rice bran combined, with rice bran last. Due to the high cost of rough rice and the low cost of rice bran, the combination of rice polish and rice bran ranked next in profit to rice polish, with rice bran alone next, then ground rough rice, and chicken-feed rice last.

Table XII gives the average sale and slaughter record for the three years. Dressing percentage followed closely rate of daily gain, and the same is true of carcass grades, and sales values per 100 pounds weight. The greater profits from feeding rice bran compared to rice polish or ground rough rice were due to the low cost of rice bran which sold for almost half the price of rough rice.

TABLE XII. Average Gains, Dressing Percentage, Carcass Grade, and Sale Value
Three year average — 1938-39, 1939-40, and 1940-41

Lot	Carbohydrate Concentrate	Daily Gain	Dressing Per Cent	Average Carcass Grade*	Sale Value Per Cwt.**
1	Ground shelled corn	2.37	56.07	13.8	$8.32
2	Ground rough rice	2.16	54.23	14.0	8.04
3	Chicken-feed rice	1.99	53.77	14.3	7.53
4	Rice polish	2.19	55.22	14.0	8.16
5	Rice bran — ½ Rice polish — ½	1.91	54.28	14.4	7.65
6	Rice bran	1.84	52.7	14.7	7.13

*Swift grades: 13 — Select; 14 — Swift; 15 — Sanco.
**Based on carcass values.

SUMMARY OF THREE YEARS RESULTS

1. The corn ration produced the greatest gains and made the best profits each year.
2. The rice polish ration produced the second largest gains and made nearly as good profits as the corn rations. With rice polish at 10c per 100 pounds lower, the cost per pound gain would have been the same as in the corn lot, although the profits would not have been quite as high, due to the higher sale price of the corn fed steers.
3. Ground rough rice produced satisfactory gains, but profits were low due to the high price of rough rice. Rough rice has about 85% the feeding value of corn.
4. Rice bran produced only fair profits when fed as the only carbonaceous concentrate or mixed with rice polish. Gains were lowest on this ration. It is not advisable to feed rice bran as the only carbonaceous concentrate in comparison with corn, unless it can be bought at a much lower price.

TABLE XI. Rice and Rice By-Products For Fattening Cattle
Three year average 1938-39, 1939-40, 1940-41
Length of feeding period 112 days. 10-11 steers per lot

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Gr.Rough Rice 12 C. S Meal 4	Chicken-feed Rice 12 C. S. Meal 4	Rice Pol 12 C. S. Meal 4	Rice Pol. 6 Rice Bran 6 C. S. Meal 4	Rice Bran 12 C. S. Meal 4
Ave. Initial Weight	459	455	458	457	457.3	457.8
Ave. Final Weight	725	698	681	702	671.6	663.6
Ave. Gain, Lbs.	266	243	223	245	214.3	205.8
Ave. Daily Gain, Lbs.	2.37	2.16	1.99	2.19	1.91	1.84
Average Daily Feed, Lbs.						
Concentrates	15.05	15.05	15.05	15.05	14.99	14.99
Alfalfa	.25	.25	.25	.25	.25	.25
Rice straw	3.12	3.67	4.75	3.68	3.52	3.58
Powdered oystershell	.1	.1	.1	.1	.1	.1
Salt	.014	.012	.010	.016	.021	.022
Feed required per 100 lbs gain						
Corn	475.5					
Rough rice		525				
Chicken-feed rice			576.8			
Rice polish				517.8	296.0	
Rice bran					296.0	615.4
Cottonseed meal	158.5	175.0	192.2	172.5	197.4	205.1
Alfalfa	10.2	11.3	12.3	11.7	12.7	13.3
Rice straw	131.4	170.7	205.0	164.3	184.8	195.0
Feed cost per 100 lbs gain	$ 9.96	$11.64	$10.77	$10.16	$10.21	$ 9.19
Ave. cost per steer	26.39	26.16	26.33	26.28	26.29	26.32
Ave. feed cost per steer	26.49	28.28	24.01	24.89	21.88	18.91
Total cost of steer	52.88	54.44	50.34	51.17	48.17	45.23
Sale value per cwt.	$ 8.32	$ 8.04	$ 7.53	$ 8.16	$ 7.65	$ 7.13
Ave. sale value per steer	60.77	56.04	51.65	57.42	51.44	47.75
Profit or loss per steer	7.89	1.60	1.31	6.25	3.27	2.52

Feed prices per 100 lbs. average: Corn—$1.47, Rough rice—$1.57, Rice polish—$1.32, Rice bran—$ .85, Chicken-feed rice—$1.21, Cottonseed meal—$1.44, Salt—$0.50, Oystershell—$0.50, Rice straw—$0.415, Alfalfa—$1.60.

5. Chicken-feed rice produced the fourth best gains but made the lowest profits, on account of its relatively high price. The value of chicken-feed rice will depend on the amount of rice grain it contains. In this test chicken-feed rice showed an estimated value of 73% that of corn.
6. The relative values of the rice feeds based on these experiments show them to have the following percentage rating for steer feeding:

Corn	100
Ground rough rice	85.3
Chicken-feed rice	73.1
Rice polish	87.7
Rice bran	66.2
Rice bran — ½ Rice polish — ½	71.4

EXPERIMENT IV — 1941-42

CORN, RICE PRODUCTS, MOLASSES, LEGUME HAY AND RICE STRAW FOR FATTENING STEERS

In this feeding trial some changes were made in the rations used. Rice polish and rice bran were fed in combination with corn rather than as the only carbonaceous concentrate as in the three previous tests. Two lots were given hay instead of rice straw, and two lots received molasses in addition, to replace part of the corn. The steers were good Hereford grades averaging over 500 pounds at the beginning of the test . It was not possible to get a uniform group of steers with respect to weight and condition. The heavier steers in each lot were marketed and slaughtered after 84 days, leaving the lighter cattle to be fed an additional 35 days. More steers were taken out of Lots 2 and 5 than from the others, making the average number of days slightly less in these lots. Two steers were taken from Lot 5 for general unthriftiness and failure to gain.

RATIONS FED

Lot
1 Corn^{12}, cottonseed meal^{3}, rice straw.
2 Corn^{9}, cottonseed meal^{3}, rice bran^{3}, rice straw.
3 Corn^{9}, cottonseed meal^{3}, rice polish^{3}, rice straw.
4 Corn^{9}, cottonseed meal^{3}, rice bran^{3}, legume hay.
5 Corn^{6}, cottonseed meal^{3}, rice bran^{3}, molasses^{3}, rice straw.
6 Corn^{6}, cottonseed meal^{3}, rice bran^{3}, molasses^{6}, legume hay.

A small amount of good green alfalfa hay was fed weekly in all rice straw lots to supply vitamin A. The hay used in Lots 4 and 6 was lespedeza and grass hay. When no more hay of this type could be located, alfalfa was substituted for the balance of the test. It was necessary to pay $19.00 per ton for the lespedeza-grass hay and $28.60 for the alfalfa. The hay would have had to be bought or produced for $14.00 per ton to have been as profitable as rice straw at $7.60 per ton.

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TABLE XIII. Corn, Rice Products and Molasses For Fattening Steers
December 1, 1941 to March 30, 1942

Lot No.	1	2	3	4	5	6
Ration	Corn 12 C. S. Meal 4 Rice Straw	Corn 9 C. S. Meal 3 Rice bran 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Pol. 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Bran 3 Legume Hay	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Rice Straw	Corn 6 C S. Meal 3 Rice Bran 3 Molasses 3 Legume Hay
Steers per lot	10	10	10	10	8	10
Ave. days per lot	112	108.5	112	112	108.5	112
Ave. Initial Weight	529.5	550.0	525.3	511.5	565.6	528.6
Ave. Final Weight	797.0	784.2	771.7	793.0	823.1	790.2
Ave. Gain, Lbs.	267.5	234.2	246.4	281.5	257.5	261.6
Ave. Daily Gain, Lbs.	2.30	2.16	2.20	2.51	2.37	2.33
Average Daily Feed, Lbs.						
Corn	10.96	8.22	8.22	8.22	5.48	5.48
Cottonseed meal	2.74	2.74	2.74	2.74	2.74	2.74
Rice bran		2.74		2.74	2.74	2.74
Rice polish			2.74			
Blackstrap molasses					2.74	2.74
Rice straw	5.24	5.39	5.69	.29	6.55	.39
Legume hay	.17	.17	.17	6.33	.17	6.96
Feed required per 100 lbs. gain						
Corn	458.4	381.1	373.3	326.7	221.4	234.4
Cottonseed meal	114.6	127.0	124.4	108.9	110.7	117.2
Rice bran or rice polish		127.0	124.4	108.9	110.7	117.7
Blackstrap molasses					110.7	117.2
Rice straw	219.5	249.9	258.6	11.6	276.3	16.8
Legume hay	7.1	8.0	7.7	252.1	7.4	298.0
Feed cost per 100 lbs. gain	$11.72	$12.18	$12.51	$12.47	$11.00	$14.07
Ave. cost per steer	45.00	45.03	44.65	44.83	48.07	44.93
Ave. feed cost per steer	31.37	28.54	30.83	35.11	28.32	36.81
Total cost of steer	76.37	73.57	75.48	79.94	76.39	81.74
Sale value per cwt.	10.15	9.70	9.97	10.07	9.77	10.05
Ave. sale value per steer	78.46	73.76	74.56	77.15	77.99	77.30
Profit or loss per steer	2.09	.19	—.92	—2.79	1.60	—4.44

Feed prices per cwt.: Corn—$1.80, Cottonseed meal—$2.20, Rice bran—$1.14, Rice polish—$1.56, Molasses—$1.94, Rice straw—$0.38, Lespedeza hay—$0.95, Alfalfa hay—$1.43, Salt—$0.50, Oystershell—$0.50.

Table XIII gives the record of weights, gains, daily rations and feed consumed per unit of gain. Due to high prices, less concentrates were fed than in previous experiments. As corn was fed in all lots, there was not much variation between the different lots either in gains or in feed required per unit of gain. Where rice bran was substituted for part of the corn ration the gains were lowered, but when rice bran and molasses were substituted for half the corn the gains were higher. The two lots receiving hay made the highest gains but were less profitable than the straw fed lots.

Profits were low due to a narrow margin between buying and selling prices. The gains made were very favorable, but with a purchase price of $8.50 and a sale price ranging from $9.70 to $10.15 there was not enough margin for profit with feed prices as high as they were in 1942. At farm prices for steers, corn, and hay there could have been a good profit in all lots.

The slaughter records, including dressing percentage, and carcass grade are given in Table XIV. There was very little difference in grade or in sale value in the different lots. The difference in quality was only .7 of a grade between the best and the poorest lots. With the exception of the rice bran lot which graded lowest there was only 2/10 of a grade between the remaining lots and only 45c per 100 weight between the best and the poorest lots on sale price.

TABLE XIV. Average Gains, Dressing Percentage, Carcass Grade, and Sale Value

Lot	Carbohydrate Concentrate	Daily Gain	Dressing Per Cent	Average Carcass Grade*	Sale Value Per Cwt.**
1	Corn, cottonseed meal, rice straw	2.38	56.7	14.2	$10.15
2	Corn, cottonseed meal, rice bran, rice straw	2.16	55.4	14.8	9.70
3	Corn, cottonseed meal, rice polish, rice straw	2.20	55.8	14.4	9.97
4	Corn, cottonseed meal, rice bran, legume hay	2.51	56.9	14.3	10.07
5	Corn, c. s. meal, rice bran, molasses, rice straw	2.37	55.4	14.3	9.77
6	Corn, c. s. meal, rice bran, molasses, legume hay	2.36	56.6	14.1	10.05

*Grades between 14.0 and 14.9 are "Good".
**Based on carcass value.

SUMMARY OF RESULTS

1. Rice straw at 20c per bale supplemented with a small amount of good alfalfa hay was more economical than legume hay at the prices paid.
2. Corn fed without rice products was more profitable at 1942 prices than when rice products or molasses were added.
3. The second highest profits were made in Lot 5, fed corn, cottonseed meal, rice bran, molasses, and rice straw. Had molasses been available at the prices paid in previous years (90c per 100) this ration would have been the more profitable. Molasses will not be available for feeding during the war.

4. Rice bran at $22.80 per ton was not as profitable as corn at $36.00 per ton. Lot 2 receiving corn and rice bran without either molasses or legume hay made lower gains than any other lot and the sale value was lower.
5. Rice polish at $31.20 per ton was not as profitable as corn at $36.00 per ton. The corn and rice polish lot (Lot 3) made less profit than Lot 2 receiving rice bran although the gains were better and the sale price higher.
6. The substitution of 33% molasses for an equal amount of corn in Lot 5 increased the gains and increased the sale price. At 10c per gallon, or 85c per 100 weight for molasses this lot would have been fed at a profit.
7. Feeding legume-grass hay increased gains and selling prices and at farm prices the hay fed lots would have made a good profit.
8. Rice straw at $7.60 per ton was more profitable than hay at $19.50 per ton.

The feeding value of rice bran and rice polish as shown in these experiments, appears to be low when compared with results obtained in feeding swine and poultry. It may be that these rice feeds are not as suitable for fattening steers as for feeding other classes of livestock. These feeds might have shown higher values if fed in smaller amounts in combination with other feeds as is the case in swine feeding. It is probable that these feeds do not combine to good advantage with rice straw as roughage. Just as the wheat products, wheat bran and middlings, have been found better adapted to the feeding of milk cows, poultry and hogs, it may also be the case with rice bran and rice polish. If this is true, the prices for these feeds will quite properly be higher than the beef cattleman can afford to pay for feeding steers.

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